THE

ELECTRICAL REVIEW.

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LIGHTHOUSE ILLUMINANTS.

AN interesting subject by no means implies that it is incapable of dull and unprofitable treatment. The members of the London Chamber of Commerce who lately listened to Mr. Wigham's lecture upon "Gas Lights, Oil Lights, and Electric Lights as Lighthouse Illuminants," were probably much disappointed. Yet they need not have been. How could they expect the inventor of a special system of gas lighting to be otherwise than profoundly impressed with the importance of his own invention? Human nature is a constant factor, and since it cannot be eliminated, it should be allowed for. Indeed, the "personal equation" of everyone is ascertainable, and if only people acquired the habit of correcting for it, there would not be so many fallacies to contend with, and a man and his work could be more accurately estimated.

We submit that Mr. Wigham, than whom none in these later days has energised more towards making our beacon lights efficient, is a gentleman with a strong bias. He is the inventor of a system of gas lighting which has given excellent results; so excellent, indeed, that he has failed to grasp the possibility that there can be any progress beyond his system. He possesses to a superlative degree that, for some purposes, admirable quality of faith in himself. Were it not that it is accompanied by a corresponding disbelief in that which does not take birth in his own inner consciousness, we should gladly bow down and worship him.

The *bias*, which we will admit to be a natural one, is very much in evidence in Mr. Wigham's lecture, for an advance proof of which we are indebted to the London Shipmasters' Society. In a sentence, his opinion may be expressed as follows:—"Oil lights are all very well in their way; electric lights are all very bad. But gas lights on my system are *facile princeps*."

To support this view Mr. Wigham has no arguments whatever beyond the opinions of three worthy ships' captains. It is true that he managed to get one of his gas lights accepted as the signal on the tower of the Houses of Parliament, and that this was arrived at after a comparison with some form of electric light had been made. But this one comparison proves nothing, especially as all the conditions and circumstances attending it are not disclosed. As for the opinions of the three ships' captains, they may be at once dismissed; not that we would insinuate that these worthy mariners were not single minded, but because selected opinions of this order are always obtainable.

In further "support," some remarks which have fallen at divers times from the late Prof. Tyndall, Sir George Gabriel Stokes, and the Right Hon. Lord Kelvin are quoted with an air of settling the whole question whether electric light is a better illuminant than gas-light. We regret, however, to find that we can discover no argument in these remarks

which would justify the inference that they were made in favour of the Wigham light. Prof. Tyndall spoke of the testimony of others; he advanced no view of his own, but called for trials in which electric light should be pitted against the Wigham light, each in its most powerful form, "and" he said, "the result ought to determine the illuminant to be employed in the future." Sir George Gabriel Stokes's remarks simply amount to this: "I, for one, would be very glad to see a fair comparison made." Lord Kelvin "perfectly agrees with Sir George Stokes in thinking that it would be desirable to see a fair comparison made."

These great names are hurled at us as much as to say: "What do you think of that?" But it does not appear from Mr. Wigham's lecture that any comparisons have ever been made, although the North Foreland experiments cannot yet be forgotten. Therefore, he must not aggrandise to his gas light the reputation of being the best possible form of illuminant for lighthouses.

We go farther, and claim that it is not proven that electric light can only be disadvantageous to navigation, inefficient in hazy weather, and dangerously bright in clear weather.

We should also like to know whether it is not desirable that the beams from a lighthouse illuminant should be made truly parallel; and whether the electric light with its approximation to a focal point does not closely effect this with a consequent less divergence than accompanies the use of gas and oil lights? These are matters which are at the root of the question, and require to be discussed before Mr. Wigham can be allowed to dismiss so lightly all illuminants other than gas.

A Protest.

It is not often worth while to draw attention to the exaggerated statements that are made by our friends the gas journals, but we do protest most strongly against some remarks made by the *Journal of Gas Lighting*, particularly as they are made with reference to a note which appeared in the Review. A few weeks ago we entered a strong argument against the Leicester Corporation doing "installation work" to the possible detriment of local firms. Our contemporary speaks of the matter as follows:—

> This resolve, of course, has aroused the ire of local firms of "electrical engineers," who have been raising in the Leicester newspapers an exceedingly bitter cry against the "undignified" action of the officials of the Corporation in "touting for installation work," and arguing in familiar fashion against the unfairness of Corporation competition with private firms, who are necessarily also ratepayers. A particular grievance urged against the Corporation is that the new department is making the profit upon the installation branch help to reduce the present loss upon the supply of current. But this is only what electric lighting undertakings have done all the world over; and sorry enough they are, as a rule, when the installation work is finished, and the generating station left to earn its own living.

If the *Journal of Gas Lighting* really desires to pose as an authority on electrical matters, a systematic reading of the electrical journals is imperative. If there is one thing that we and our electrical contemporaries have endeavoured to show it is that an electric lighting supply can be conducted with profit without any help from extraneous work. The statement that electric light undertakings have generally undertaken "installation work" is, so far as this country is concerned, contrary to fact. Perhaps our contemporary in its endeavour to show the weakness of electric supply may be induced to publish a list of those companies and corporations which, in addition to supplying electrical energy, undertake wiring work.

The Highest and the Lowest.

We have recently seen a list of tenders which again forcibly illustrates the difficulties that electrical firms have to contend with. The highest tender is £1,705 and the lowest £1,245. The system for which tenders have been asked is to comprise 531 incandescent lamps varying from 8 C.P. to 50 C.P., and the plant is to be capable of furnishing energy to 650 16-C.P. lamps. The firms who submitted estimates had a most elaborate specification to go upon, so that there could be no misunderstanding about the engine, dynamo, spare armature, the main switchboard, and five sub-switchboards. Assuming that the specification were adhered to it would be impossible to provide the foregoing for much less than £790. In addition, the engine has to be connected to a range of boilers, and the necessary exhaust piping has to be provided. Allowing £25 for this, £15 for link belt, and £50 for architect's fee, for which the specification stipulates, there remains £365 for wiring and fitting 531 lamps. Surely such a sum would be totally inadequate to do the work in a substantial manner. It is also to be remembered that the firm which has sent in the lowest tender will have to buy engines, dynamos, switchboards, &c., but expects, no doubt, to get a profit on the wiring. When we see the names of well-known engineering firms on this list tendering at £300 and £400 higher than the sum we have mentioned, we wonder how the work will be done if the lowest tender is accepted. May be this tender is in accordance with that policy of taking work for the advertisement—a course which has been so often adopted by young firms with the most disastrous results.

Light and Electrification.

Professor Lodge contributes an interesting article to this month's *Science Progress* on photo-electric action, or the effect of light in facilitating the discharge of statically charged conductors. This is virtually a new branch of physics originating from an experiment of the celebrated Hertz, the influence of whose discoveries is now being felt in many departments of electrical science. Hertz observed that the sparking of an induction coil was facilitated when the light of another spark fell upon its secondary terminal. Further experiment showed that this effect was due to the ultra-violet rays, and that the neighbourhood of the negative pole was the most sensitive part of the spark gap. It appeared from this that negative electricity would be more readily discharged than positive, and this was found as a rule to be the case. If ultra-violet light is allowed to fall upon a freshly scraped zinc disc forming the cap of a negatively charged electroscope, the charge will leak rapidly away. The most effective metals were found to be the alkalies, such as potassium and sodium, and the least effective, the noble metals, such as gold and silver. It was found, in fact, that if metals were arranged in the order of their facility for discharging negative electricity, they took the order of the voltaic series, a fact which indicated that electro-chemical action had something to do with the effect. Elster and Geitel, by the use of polarised light, showed that oscillations of light waves, perpendicular to the surface of the metal, produced a more rapid discharge than those parallel to it. The dissociation of molecules which is now considered to accompany the breaking down of electric strain, would appear from these experiments to be facilitated by light vibrations when applied in the direction in which the ions travel.

ELECTRIC LIGHTING AT HONG KONG.

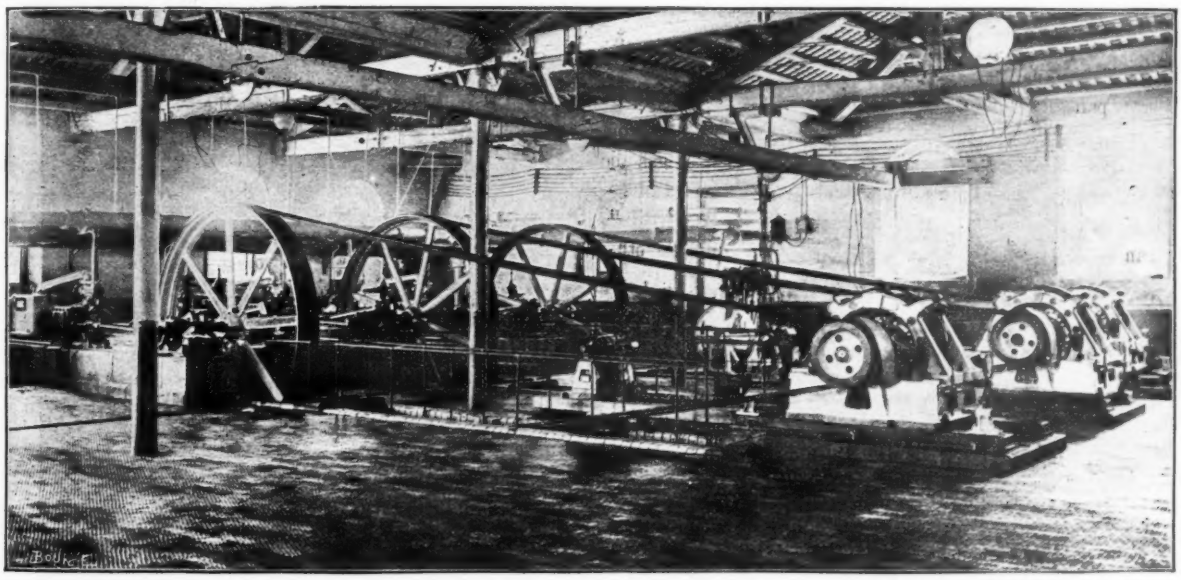
THE central lighting station at Hong Kong, of which an interior view is shown in the accompanying illustration has now been in successful operation for 4½ years, it having been installed, and the public lighting started, in December, 1890.

It was designed by J. W. Hart, Esq., M.I.C.E., of 39, Victoria Street, Westminster, for the Hong Kong Electric Company, Limited, and the whole of the plant, including engines, boilers, dynamos, motors, switchboards, lamps (arc and incandescent), mains, columns, &c., was supplied by Messrs. Johnson & Phillips.

The station is situated at the east end of the town of Victoria, Hong Kong, in the Wanchai district.

It is built on the side of the hill, just below the aqueduct which supplies Hong Kong with water, the ground having been cut in two steps or terraces, on the upper of which the engine room is built, and on the lower the boiler house, stores, and offices.

The engine room is about 100 feet long by 75 feet wide, and contains five horizontal compound engines of 90 nominal horse-power, with jet condenser at the back of the low pressure cylinder. The engines run at 100 revs. per minute. The fly-wheel, which is between the high and low pressure cylinders, is 13 feet in diameter, with six grooves on the face for 1¼-inch diameter driving ropes leading direct to the countershaft for driving the dynamos. There are two patent feed-water heaters.



The water supply for the condensers is obtained from a tank about 75 feet by 50 feet by 8 feet, dug out of the hill at the back of the engine room, and fed by a small stream from the hills. The boilers are also supplied from this tank, but during the dry season are fed from the town supply.

The cold water from the hills runs in at the bottom of the tank, and the supply to the condensers is also taken from the bottom. The water, after being used for condensing purposes, is discharged into the same tank, but at the surface level to facilitate cooling, and is again re-used.

The boiler house, which is on the lower level, is reached by a flight of stone steps. It contains three steel Lancashire boilers with Galloway tubes. The boilers are 26 feet 6 inches long, and are worked at a pressure of 140 lbs. to the square inch. They are supplied with water both by injectors and by two donkey pumps. As a rule, only one boiler is in use, but a second is kept under steam in case of accidents. There is a large space for coal storage alongside the boilers.

The flue which passes along the back of the boilers passes through the wall and into the chimney shaft, which is 75 feet high. Japanese coal is used, and, although rather smoky, gives very little trouble in keeping steam. Next to the boiler house is a store for cables and line materials, and there is also another large store fitted up with shelves all round, and having a gallery round it for the storage of electric light fittings and glass.

There is a small office fitted up for testing, and for regulating and testing the meters for the house supply. The alternating meters are of the shunt type.

The three arc light dynamos, which are fitted with automatic regulators, are each of 55 lights capacity, and are run off a countershaft by belts. Two horizontal and one vertical engine work on to the countershaft, and each engine and dynamo pulley on countershaft is controlled by a patent friction clutch, so that any engine or dynamo can be changed while running without interrupting the lights in the event of a breakdown. There is a spare armature for the arc light machines which will fit any machine.

The alternators are of 50 kilowatt Kapp type, running at 650 revolutions per minute, with 75 ~, and giving 2,000 volts, and are placed on slide rails with shifting screws, and bolted down to solid brickwork and granite foundations.

The arc light dynamos are laid on balks of timber, bolted down to brickwork foundations, and the machines are surrounded by a wooden platform on oil insulators, to guard against the danger of shocks to the dynamo attendant.

The alternators are excited by Kapp dynamos, giving 50 ampères and 150 volts, which are driven by belts off the alternator shafts. An overhead travelling crane runs across the engine room for handling the heavy parts of the machinery.

Johnson & Phillips's transformers, transforming from 2,000 to 100 volts, are used in the houses for private lighting. The switchboard, which is at the back of the engine room, is of teak, and is about 3 feet away from the wall, thus allowing access for connecting up the leads.

All the instruments are mounted on enamelled slate slabs, arranged, one for switch gear for the alternating circuits, two for fuses for the same, one exciter circuit board, and one 1-light circuit board.

Lightning arresters, of the magnetic air gap type, are placed on each pole of every circuit, leaving the switchboard to protect the dynamos and instruments. These were adopted in preference to the Brush type, which, we understand, did not answer in the severe storms which Hong Kong is subject to, and it was no uncommon thing to have the arc circuits struck and short-circuited 20 or 30 times in an hour during a heavy storm. Sometimes it was impossible to keep the incandescent circuits going, as the fuses were blown as fast as they were replaced, owing to the lines being repeatedly struck.

However, after the adoption of magnetic arresters in the station and Wurtz arresters at intervals along the lines, there were seldom any mishaps. In front of the switchboard is a platform laid with rubber mats, and guarded by a rail to guard against accidents from shocks.

Each arc light machine has also a patent regulator on the switchboard.

The principal streets are lit by 80 double clutch non-focussing Brockie-Pell arc lamps. These are fixed in carriers with a reflecting hood, and placed on top of iron lattice poles 40 feet high, except in a few cases where shorter poles were found necessary. These posts carry wrought-iron brackets, on which are fixed insulators to carry the cables both for the arc lamps and incandescent circuits.

Wrought-iron taper poles with cast-iron bases are also used for carrying the leads.

Johnson & Phillips's patent fluid insulators are used for carrying the stranded steel bearers.

The cables, which are 7/16 stranded wire, are of high insulation vulcanised rubber, and are suspended from the steel bearers by porcelain insulators.

An earth wire connects all the posts and lamp-posts together to guard against lightning. There are two incandescent and two arc light circuits. The Government House, the Hong Kong Club, the principal banks and residences, are lit with incandescent lights, there being in all about 10,000 lamps.

In spite of the fact that the overhead wires have on several occasions been damaged by fire and blown down by typhoons, the company consider that they were well advised in adopting the overhead system, as the other alternative of putting the wires underground would have been exceedingly costly, owing to the nature of the ground, which is nearly all solid granite. As it was, many of the holes for the posts had to be blasted out with gunpowder.

In connection with the troubles with typhoons, it may be interesting to mention that on one occasion some Chinese junks were blown right up against the sea wall, and their masts becoming entangled with the cables which ran alongside, brought them down to the ground, together with some dozen posts which carried them. Strange to say, no interruption occurred to the lighting, thanks to the good insulation of the cables, and the station officials were not even aware of the accident until the following morning.

There is a handsome house built on the hill at the back of the station and approached by a flight of steps, for the use of the staff, which consists of two electricians and an engineer. The manager, Mr. W. H. Wickham, lives in another part of the town. The Chinese staff comprise about 24, there being two head engineers, one taking duty by day and the other by night, also fitters, dynamo attendants, greasers, and stokers, and about 10 linesmen for outside work and for house wiring.

There are two Portuguese foremen for superintending the house wiring. The Chinese staff are very intelligent and soon learn the work, and make very good wiremen. The company being the only electrical engineers in Hong Kong, have done a lot of ship lighting and repair work for mail and cargo boats entering the harbour.

The works were erected under the personal superintendence of the present manager, Mr. W. H. Wickham, and have given the most satisfactory and efficient results during the whole period from date of incorporation in December, 1890. In the work of erection, Mr. Wickham was seconded by Mr. G. Sanderson, one of Messrs. Johnson & Phillips's engineers.

RECENT EXPERIMENTS ON THE ELECTRIC DISCHARGE BY LORD ARMSTRONG.

(Concluded from page 640.)

This peculiar quasi-circulation in the electrostatic field which Lord Armstrong's experiments appear to indicate is of the greatest theoretical interest. Several experimenters have obtained analogous results, and attempts have been made to explain them, which, however, do not appear altogether satisfactory. Faraday, in 1838, observed the movement of dust particles, and silk fibres in non-conducting liquids, in the opposite direction to the current, and also a convective movement of the liquids themselves in the same direction as the current; and many other experimenters have made similar observations with a variety of other powders. Electric convection is considered to be due to layers of the dielectric liquid in contact with the electrodes getting surcharged with electricity, owing to the fact discovered by Quincke, that conduction in such liquids does not follow Ohm's law, the current increasing faster than the E.M.F. Near the electrodes the fall of potential is more rapid than in intermediate parts of the field, and consequently electricity will flow more rapidly into the liquid from the electrodes than it is drawn off by the field beyond. The surcharged layers of the liquid are repelled, and thereby produce a convective movement. The movement of suspended particles in the opposite direction to this convective current in the liquid is considered by Quincke and Helmholtz to be explained by supposing that the contact of the liquid and the particles gives them opposite charges. This explanation, however, appears to be incompatible with Lord Armstrong's experiment, where the cotton thread is connected to the positive electrode, and therefore must have the same kind of charge as the convective liquid current moving away from the positive pole.

Fig. 7.

Another group of Lord Armstrong's figures show some peculiar photographic actions of the discharges. It has long been known that under certain circumstances the lightning flash produces a reversed image or "dark flash" on the photographic plate. This subject has been investigated by Clayden*, who came to the conclusion that the reversal of the image of the lightning flash was due to the superposition of light reflected from white clouds striking the photographic plate before or after the flash. He found the "dark flash"

Phil. Mag., Vol. xxviii., page 92, 1889.

had frequently a white core, and this he found he could reproduce in photographs of sparks from an influence machine, when these sparks were produced by large Leyden jars, but not when the fainter sparks from smaller Leyden jars were used. In the latter case there was no white core, the whole of the spark image was reversed. The existence of the white core, therefore, may plausibly be attributed to concentration of the current on the surface of the spark, a well-known property of alternating or rapidly varying currents such as we have in the electric spark. The more intense light produced by this stronger surface current may produce reversal of the photographic image, while the less dense current at the centre does not reach the reversal point. Fig. 7 shows a discharge containing a dark spark with a white core, which can be seen much better in the enlarged view of the same (fig. 8). Figs. 9 and 10, however, show how incomplete this explanation of the dark spark is. Fig. 9 is an enlarged view of the horns of part of a brush discharge. The branches of these horns can be seen to overlap or coalesce at several points. The image at these points is brighter, though according to the theory just explained these points ought to be dark owing to photographic reversal. In fig. 10 we have an effect which as far as we know is quite novel, namely dark points upon white sparks. These dark points occur apparently where the branches terminate in air before they reach the negative pole. This peculiar effect, if photographic, would imply that the points of these sparks were much more luminous than the rest of the spark. But the effect may be electrolytic, as there is always a probability of some electrolytic action when the discharge is made over the surface of the sensitive film of a photographic plate. At the positive end of a spark, oxygen or halogen compounds would be produced

Fig. 9.

by electrolysis, and it is well known that the presence of such compounds in the sensitive film favour reversal of the image.

Fig. 8.

Fig. 10.

Here, however, they appear at the negative end, and therefore if this theory be correct the dark points must have been produced by a reflected wave of current, which temporarily converted the end of the spark into a positive electrode. Fig. 11 represents the effect produced by a discharge from the air upon a negative point. The shape of the horns is said to bear a very close resemblance to those seen in solar eclipses.

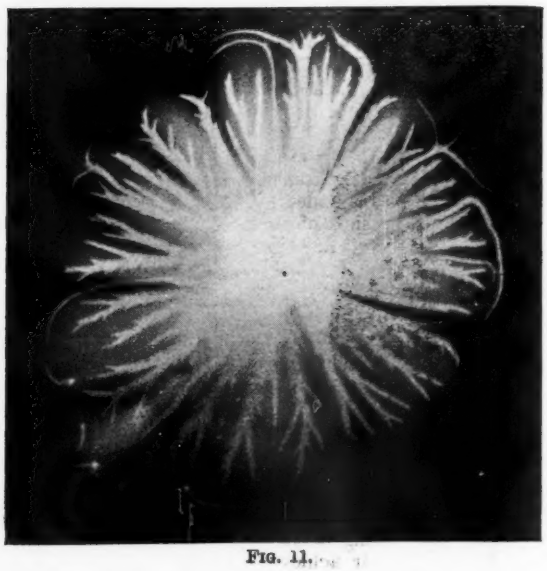


Fig. 11.

These beautiful figures obtained by Lord Armstrong will, we do not doubt, be of the greatest interest to students of electrical theory, and as a distinguished physicist has remarked, they would be very instructive if we only knew what they meant.

THE JAMES FORREST LECTURE.

In his choice of a subject for this year's lecture, we think that Prof. Unwin has been decidedly happier than at least one of his predecessors. Avoiding all reference to questions of class distinctions and sociology, he took for his subject the history of the experimental investigation of the steam engine. The steam engine is a subject of perennial interest to engineers, "Age cannot wither nor custom stale her infinite variety."

Nor need this be a matter of surprise. The steam engine is something more than a mere prime mover. It is that par excellence, but it also affords an object lesson in mechanics, and in physics; and in comprehending the behaviour of the working fluid, it is necessary to have a keen appreciation of the interaction between that fluid and the vessel in which it is confined with a full comprehension of all the results that follow upon the use of a fluid which the able lecturer defined as "a vapour of the greatest instability, liable to condense or to evaporate on the slightest change of thermal condition," a vapour, we might add, which has an infinity of critical temperatures and pressures. So far as could be compassed within the bounds of a single short lecture, Prof. Unwin's remarks got at the kernel of steam engineering science, and show us, in the first place, how much was really known in the early days of the science, and how many have been the slips backward in practice. Indeed, the backslidings of the practical man may almost be said to warrant the lecturer's contention that advance in steam engine improvement has been due rather to the professors than to the practical men, for, says Mr. Unwin, Watt was a philosophical instrument maker when he improved the steam engine. Watt set on foot the first Cornish duty determinations, but his connection with Cornwall ceased in the year 1800, and, after that, Cornwall fell from grace until Captain Joel Lean set the tests going again, and under their influence, from 1815 to 1840, the duty per pound of coal was more than doubled, and the horse-power was obtained in the latter year

with 1·7 lb. of coal, a figure we may compare to-day with that of Mr. Leavitt's St. Louis pumping engine, viz., 1·33 lb. coal per I.H.P. hour. The lecturer showed that Woolf tried compound working in 1812, but the principle failed to realise an economy, but he did not state why this failure occurred. The reason of failure was, we would add, two-fold. In the first place, it is likely that the thermal economies which compounding could effect were of insufficient amount with the pressures of the day to counterbalance the inevitable losses incident upon the increased friction and general mechanical complication of the compound engine; and, secondly, the engines of Woolf were not, we believe, designed as we now design a compound engine. Hornblower, in or about the year 1781, first compounded the steam engine, and the principle was revived by Woolf in 1804, though Woolf was under a curious misconception as to the powers of expansion of steam. Both Woolf and his predecessor Hornblower, however, neglected, or, more probably, were ignorant of the true secret of economy in compounding, viz., the division of the temperature range into stages, for both these men used a comparatively small high pressure cylinder, and carried steam the full stroke in this cylinder, and *all expansion took place in the second cylinder*. Both cylinders were thus exposed to the full range of temperature, and we can hardly wonder that compound working was a failure, for such a system of working entirely foregoes the thermal advantages of double-cylinder engines, and leaves cylinder condensation in a more powerful position for wreaking its ill works than in single engines. We should like this point to have been referred to and amplified by Prof. Unwin. Referring to boilers, he remarked that boilers differ very little in their achievements, and, practically, that all coals of good English quality are about equal in power. Speaking of the Dasymeter, a modification of which instrument was recently noticed in our columns as the Econometre exhibited at Antwerp last year, he thinks, in the future, that this instrument for determining the ratio of CO_2 present in the flue gases will be as common as the pressure gauge, and it does indeed seem strange that so important a substance as air should be left so entirely to chance in all furnace work. If air had to be purchased by steam users at a fair price, they would see to it that coal was burned with an amount as close to the chemical minimum as possible.

Isherwood's experiments come in for remark. Isherwood was doubtful of the advantages of expansion, which he considered over-rated, and is accused of making a blunder in neglecting in a simple calculation the fact that in expansive working of steam, part of the work is done in the cylinder, and is therefore accompanied by condensation, and part—that during admission—is done in the boiler with heat derived, so to speak, directly from the furnace. If the true facts were not grasped by him, he did at least grasp the fact that water in the cylinder had a very bad effect, and is credited with this. It appears that Isherwood condemned both jackets and superheating, and he also attacked the compound engine; but the lecturer only quotes him as attacking Hornblower's or Woolf's system, and in this we perfectly agree with Isherwood's condemnation, though our grounds are essentially not those of Isherwood.

Carnot and Joule are named as the founders of the science of thermo-dynamics, from which has sprung so much of modern steam engineering science, through the labours of Hirn, Rankine, Clausius and Zeuner. At this point, the lecturer stepped aside to point out how mistaken were those electrical engineers who, realising 90 per cent. from their dynamos—"mere masses of metal and wire," are apt to condemn the steam engine as a barbarous machine, because its efficiency is so low. But the steam engine actually is fairly efficient, in that natural laws step in to limit the attainable, and the engine has allotted it only a fraction upon which to commence work. It was to Hirn, however, that we owe so much of our modern conception of the steam engine in its complicated internal actions. Not only did he, in 1854, verify within 1 per cent. by an engine test, the truth of Joule's discovery, and show that heat disappeared in the performance of work, but he fully established the utility of steam jackets in 1855 to 1856, and of superheating in 1857. It was by these various trials that Hirn came to perceive the facts of cylinder condensation; but in this connection the name of D. K. Clark might well have found a place, for to him belongs, we believe, the credit of first pointing out the facts as to this phenomenon. We need scarcely say that Prof. Unwin believes in superheating. So far as he can ascertain, "no difficulty arises in using steam superheated to 500° F.," and "in good and large engines, steam consumption is reduced 15 per cent. by superheating 100° F.," and he looks forward to the large use of superheating, and advocates at least 100°, quoting a consumption of only 10·2 lbs. per H.P. hour where superheated steam of 670° was used with a boiler pressure of 165 lbs.

While awarding high praise to the late Mr. Willans, it is plain to see that Prof. Unwin thinks that Willans has been somewhat misinterpreted by his immediate successors, even though they may not exactly wear the prophet's mantle. The so-called Willans law of the linear equation has been overstretched, and is being used with little discretion. As a fact, Willans's experiments are a quarry of scientific data, but so far the quarry has been unworked. A short reference to the purely dynamical actions of the steam engine conclude the lecture. If one-half the friction of our engine is generated in the crank-shaft bearings, it would appear that upon this detail much may be spent by way of reducing its friction with very satisfactory results in fuel saved.

Altogether the lecture was exceedingly interesting, the subject of it being handled by one so familiar with it, and though we may not altogether agree with his praise of the labours of the scientific man, we suppose that this was necessary to effect some sort of contact with Mr. Forrest's desire that the lectures should show the dependence of the engineer on the mathematical and physical sciences. But is it not a fact that it is to the practical man that such application is more due than to the professor, for Watt was, after all, a practical man—a *maker* of instruments, and Hirn was anything but a professor, while Joule was essentially a practical man, and determined J by sheer practical mechanics and physics.

VARIATION OF INTERNAL RESISTANCE OF A VOLTAIC CELL WITH CURRENT.*

By HENRY S. CARHART.

It has long been known that the internal resistance of a voltaic cell, when at a constant temperature, has not a fixed and finite value, but that it is a function of the current flowing through it. The methods commonly employed to measure this resistance are not sufficiently exact to exhibit the relationship in question with satisfactory accuracy. But if the condenser method be employed,† together with certain auxiliary appliances to secure very brief and uniform closing of the circuit through different external resistances, while the potential difference between the battery terminals is measured within this short interval, then results can be obtained which plot as a smooth curve.

The resistance measured is a quantity satisfying the equation

$$r = \mathrm{R}\,\frac{\mathrm{E} - \mathrm{E}'}{\mathrm{E}'}, \text{ or } \frac{\mathrm{E}}{\mathrm{R} + r} = \frac{\mathrm{E}'}{\mathrm{R}} = \mathrm{I},$$

where r is the internal resistance, E the electromotive force of the cell, and E′ the potential difference between the terminals when closed through an external resistance R. To determine the relation between r and I, the potential difference, E′, must be measured with different external resistances in succession. For this purpose, the operations of closing the circuit, charging the condenser, discharging through a ballistic galvanometer, and finally opening the circuit, must be done by some mechanical device, by which all of them can be repeated in precisely the same interval of time. The disturbing influences due to absorption of the condenser and polarisation of the cell are then as nearly eliminated as possible.

For this purpose I have made use of a pendulum consisting of a long narrow frame pivoted at the top, and carrying

* From the *Physical Review*.

† Carhart's primary batteries, p. 116.

a heavy bob at the bottom. The bob swings between two curved rails, concentric with the axis of suspension of the pendulum, and each rail supports two keys, which can be clamped on it in any desired position. A vertical lever on each key holds it closed on the lower contact; but when the pendulum sweeps over the rails it throws these levers over, and allows the spring keys to make contact on the upper point. The contacts are all platinum, and the base and pillars of the keys are hard rubber. When care is taken to adjust the contacts properly and to keep them free from dust, their performance is in every way satisfactory.

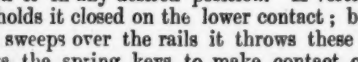


FIG. 1.

Fig. 1 shows the connections for the measurements in hand. Keys K_1 and K_4 are on one rail, while K_2 and K_3 are on the other. When the lever of K_1 is thrown forward while that of K_4 is up, the battery circuit is closed through the resistance R. When the lever of K_2 is thrown over while that of K_3 is up, the battery is charging the condenser, C; but as soon as the lever, K_3, is thrown over, the cell is disconnected from the condenser, and the latter is instantly discharged through the galvanometer, G. The pendulum swings from left to right on removing a detent. If all the levers are up, it closes the battery circuit on reaching K_1, charges the condenser by throwing over lever K_2, discharges it through the galvanometer by means of K_3, and finally opens the battery circuit on passing K_4. The key levers remain forward out of the way of the pendulum bar as it swings back again to the detent. The keys can be set as close together as desired. The length of the pendulum is such that its period is a second. Hence the time during which the battery circuit remains closed can be calculated. To get the deflection proportional to the total electromotive of the cell, the levers of K_1 and K_4 are both left down. The pendulum then charges and discharges the condenser, the circuit through R remaining open.

The change of resistance with the current is exhibited in a marked degree by "dry cells." The table contains the

d_1	d_2	n	r	i
271	258	400	21·1	0·0028
	249	200	17·7	0·0056
	238	100	13·9	0·0105
	227	50	9·7	0·0203
271	223	40	8·6	0·0249
	218	30	7·3	0·0324
	212	20	5·56	0·0473
	204	15	4·93	0·0607
	194	10	3·96	0·0868
271	172	5	2·87	0·1538
	164	4	2·59	0·1838
270	153	3	2·29	0·2289

data of a series of measurements on a Gassner cell, whose electromotive force was 1·213 volts. The first column contains the deflections due to charging the condenser with the whole electromotive force of the cell, and it will be seen that the polarisation was inappreciable. The second column contains the deflections due to charging the condenser with the potential difference at the extremities of the cell when closed through the resistances in the third column. The fourth column contains the resulting internal resistances, and the last column the currents.

In fig. 2 these internal resistances and the corresponding currents are plotted as co-ordinates. It cannot be objected that the relatively low resistances with the larger currents are due to polarisation; for, while it was demonstrated that polarisation did occur within the small time interval required for the pendulum to swing from K_1 to K_4, yet the effect of such polarisation is to diminish the potential difference

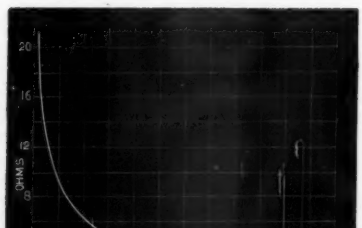


FIG. 2.

between the terminals of the cell when on closed circuit, and this effect increases the computed internal resistance.

The Gassner cell was an old one, and its internal resistance was above the average; but other dry cells show the same characteristic curve, differing only in the relative values of r.

A Daniell cell shows a similar decrease in r with increase in current, but the decrease is much smaller, and the curve is more nearly a straight line.

CHELTENHAM ELECTRIC LIGHTING.

ALTHOUGH the electric lighting of Cheltenham does not constitute any great departure from general practice, some of the details of the system are interesting, and well worth consideration. The early experience of Cheltenham has been similar to that of other towns. They have encountered local opposition of a violent nature, and they have suffered from the procrastination of the Local Government Board. A provisional order was obtained as far back as 1889; but this step was apparently taken rather with the object of preventing the entry of joint stock enterprise than with the definite idea of immediately embarking upon a scheme. Towards the expiry of this order, however, signs of awakening were manifest on the part of the companies, and in August, 1893, the Corporation decided to proceed with the lighting of the borough. Corporation proposes and Local Government disposes, for though application was made to the Local Government in August, 1893, to borrow money, it was not until March, 1894, that the necessary sanction was given.

The system is primarily one of high pressure alternating current, with transformer sub-stations. The works are about a mile and a half from the centre of the town, and it is interesting to record the reasons which led the Corporation to adopt the present site. Before doing so, however, we would mention that the scheme for lighting the borough was drawn up by Mr. Hall, the Borough Surveyor, with the assistance of Mr. Kilgour, who has since been appointed Borough Electrical Engineer. Before committing themselves, however, the Corporation sought further advice, and applied to Prof. Ayrton, who approved the scheme. Subsequently Mr. W. H. Preece was good enough to gratuitously advise the Corporation, and Mr. Hall's scheme being again commended, it was proceeded with.

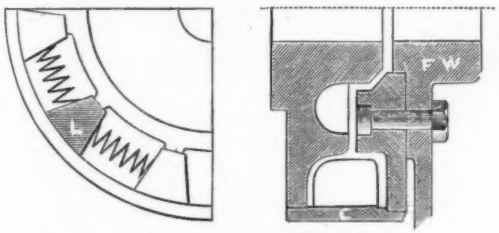
The reasons which led the Corporation to go some distance outside the town in preference to building the works in close proximity, were that the site was adjoining the destructor, the land was owned by the Corporation, and a chimney stack used for the destructor could be also utilised for the electric lighting works. In addition to the foregoing advantages, 60 or 70 horse-power was available from the boiler which was in the refuse destructor; its proximity to the Midland Railway would enable coal to be delivered to the boiler house

without the cost of carting and unloading, and what is of the greatest importance in these days, the Corporation were not likely to be indicted for nuisance. In consequence of the chimney shaft being built, and a certain amount of steam power being available, the cost of the works has been kept remarkably low, the whole system not having cost more than £16,000. We shall not expatiate upon the architectural properties of the buildings, on the principle that good wine needs no bush. It has been the aim to make the station as much like a workshop as possible, and the designers have entirely succeeded. There is no unnecessary ornamentation, even whitewash being dispensed with. On the whole, we prefer Cheltenham station, with its plainness, to many others with tiled floors and art colourings. In order to meet extensions with facility, one of the end walls is temporary. The arrangement of the plant is convenient, and fairly accessible.

In many respects the works are simply a repetition of what has been laid down at Bristol, Hampstead, and elsewhere, the generating machinery being Siemens alternators direct-coupled to Willans high-speed engines. It is not surprising that local authorities should look with favour upon this combination, which is compact, easy to manipulate, while its economical characteristics, a matter of great moment to a municipal body, have been firmly established.

The works are small, but local conditions called for no elaborate measures to commence with. We have so often described the type of generating plant that is in use here that it is only necessary to give the sizes. There is a Willans II engine coupled to Siemens W 32 alternator giving 50 a. at 2,200 volts when running at 350 revolutions per minute. In addition there are two smaller sets comprising two Willans GG engines coupled to Siemens alternators of 15 a. at 2,200 volts when running at 466 revolutions per minute. The alternator shaft is in each case lengthened to accommodate a Siemens H D 10/6½ exciter. The steam pressure under which the first engine works is 105 lbs. per square inch, while the remaining two are supplied at 65 lbs. per square inch. The alternators have a ~ of 93.

The means employed in coupling the dynamo machine to the engine are worth noting, because they permit, without injury, of slight variations from the rigid conditions that have been hitherto necessary for the good performance of direct-coupled plants; for instance, they obviate the trouble that might arise from imperfect alignment. The couplings, which are of spring type, consist roughly of two discs, one mounted upon the engine fly-wheel, and the other upon the dynamo spindle. Each disc has projecting lugs upon its face, and the two sets of lugs engage with one another through spiral springs placed between them, as in the subjoined sketches.



L, lugs; F W, fly-wheel; C, casing.
FIGS. 1 AND 2.

The steam raisers consist of two Galloway boilers, whose measurements are 24 feet in length and 7 feet in diameter. They will each develop 230 horse-power. A somewhat unusual arrangement is that the boiler house is open on two sides, and though this may be objectionable in some respects, it certainly facilitates the passage of the stokers from the boilers to the destructor. As we have already mentioned, in addition to the foregoing steam raisers, it is proposed to utilise the steam from the boiler in the refuse destructor. Hitherto this boiler, which was erected a few years ago, has been used for disinfecting purposes. It is thought that by utilising this steam supply during the period of light load considerable saving may accrue. We understand from tests which were made some time ago that 60 H.P. was obtained at the boiler, but inasmuch as the steam passes through the pipe which is in the open air and is 100 feet in length, it is naturally to be expected that this 60 horse-power will be whittled down when it arrives at the engine cylinder. To what extent it may be diminished it is impossible to say at the moment, but we do not think that it will be serious enough to affect the question of whether or not the utilisation of the heat from the destructor will not prove a great source of economy. The steam pressure of the destructor boiler does not exceed 60 lbs., but we believe it is the intention of the Borough Surveyor at a convenient period to supersede it by a high pressure boiler. It is impossible to say at the moment whether any charge will be made by the destructor department for the steam that is obtained from the destructor boiler; we assume that will depend on how far the exigencies of the electrical work interfere with the former functions of the boiler. If the steam has been hitherto considered more of a waste product, then the electric lighting ought to obtain the full benefit without charge, in the same way that it derives a free and unrestricted use of the chimney shaft which was erected solely for destructor purposes. It remains to be seen whether the burning of refuse will furnish heat enough to generate steam for light loads all the year round. No doubt the burning qualities of the refuse will vary according to the period of the year—though we are speaking without knowledge of the method of collecting refuse employed in Cheltenham—and it may even be found necessary to occasionally improve the calorific value of the refuse by a judicious intermixture of coal, but it is quite obvious that great saving will accrue to the undertaking if full advantage is taken of the destructor. It might be mentioned that the refuse destructor was erected by Messrs. Manlove, Alliott and Co. some years ago, it being a special side by side arrangement of eight Fryer's cells.

The main steam pipe is arranged on the ring system, Hopkinson's parallel slide valves being used. It will be seen from the illustration that only the branch steam pipes to the engines are in the engine room, the main being in a space between the boiler house and engine room. The exhaust pipe passes along the floor. Mr. Kilgour has designed an automatic valve, which opens the exhaust system to the atmosphere when the necessity arises, the valve being opened by the undue pressure of the exhaust steam; the valve may be also operated by hand. We have not yet mentioned that the engines are condensing, an ample supply of water being derived from the adjoining river Chelt, although in addition an abundance of well water exists. Alongside the dynamos is a combined plant erected by Messrs. Belliss which consists of a condenser with air circulating and feed pumps compactly arranged in connection with it, figs. 3 and 4. The condenser has ¾-inch tubes, giving a total cooling surface of 700 square feet, the water being arranged to pass twice through the tubes. The air and circulating pumps are identical in design and dimensions, being double acting with a diameter of 12 inches, the stroke being 6 inches. They are driven direct by a prolongation of the H. and L. P. piston rods. The steam cylinders are compound, 6 inches and 10 inches diameter, the L. P. being arranged to exhaust direct into the condenser. The feed pump, also double acting, 2¼ inches diameter by 7 inches stroke, is placed between the larger pumps and driven by an eccentric from the crank shaft. The condenser steam is discharged by the air-pump into the hot-well placed above the level of the condenser. In the hot-well are arranged a series of strainers for the removal of the grease and other impurities from the feed water on its way to the feed pump suction. In addition to the main feed pump, described above, there is an auxiliary feed pump of the Worthington type placed in the boiler room.

The switchboard is of the most simple description. There are panels for the machines, feeder panel and fuse, and synchronising panels. Ample space has been provided at the back of the switchboard by means of a covered lean-to erection, which is a distinct improvement on the usual methods. The outer or return main is led to plates which are placed in the bed of the adjoining river.

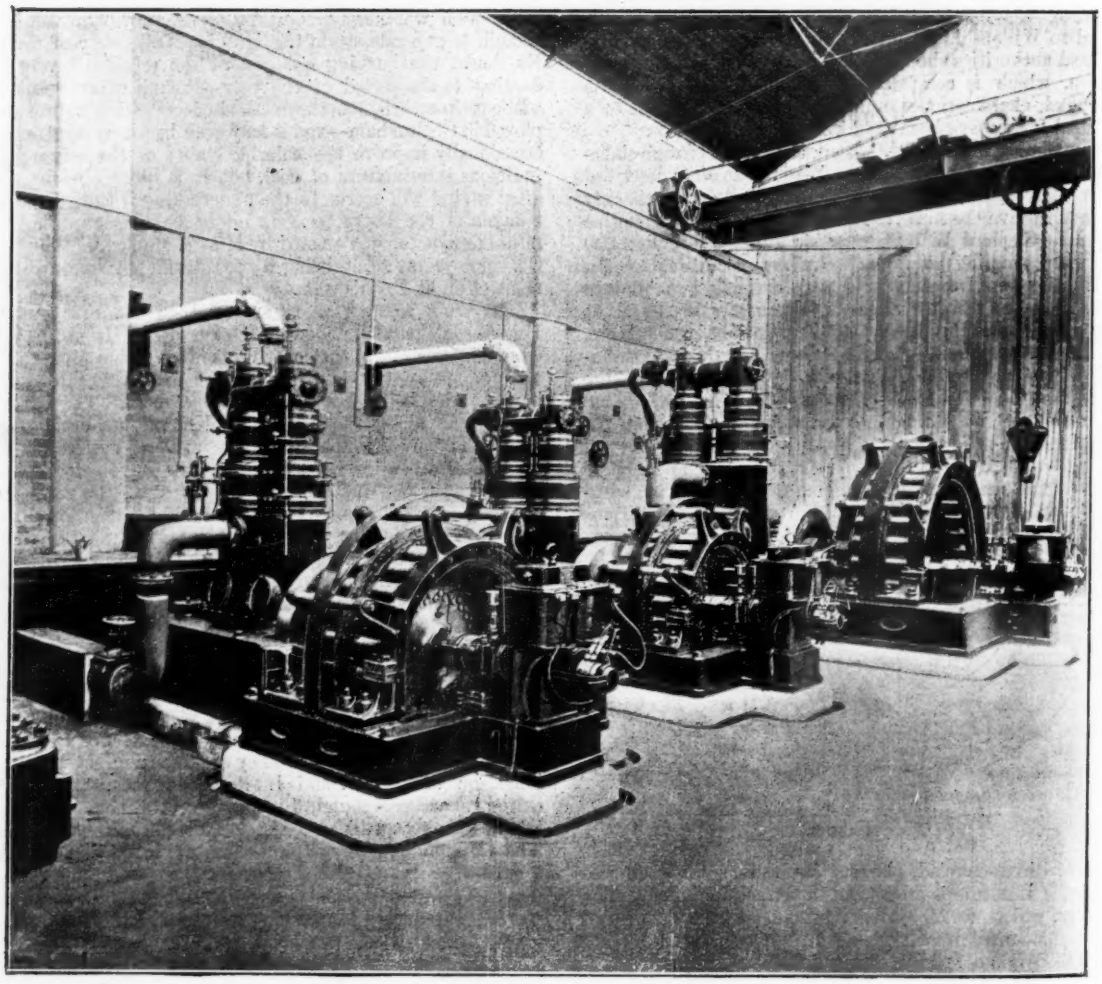
All the mains in use at Cheltenham, both for the high-pressure feeders and the low-pressure distribution network, are concentric, and have been manufactured and laid by the Callender's Bitumen, Telegraph and Waterproof Company, Limited, whose resident engineer on the work was Mr. G. Barnard.

Both conductors are insulated, the dielectric consisting of bitumenised fibre. A solid tube of lead is laid direct on

the outer dielectric under hydraulic pressure, and the cable is finished by armour, where it is required for laying direct under the ground, or it is braided over the lead when required to be drawn into the conduits.

The only difference in the cables used for high and low pressure current is in the radial thickness of the dielectric, and in the tests to which they are subjected before leaving the factory.

The high-pressure trunk main which connects the generating station with the distribution network ends at Manchester Street, where a convenient sub-station has been constructed. The building, which has been specially erected for the accommodation of the transformers, is large enough for all possible requirements, and provides space for other departments of the Corporation. The length of this main is 2,100 yards, and the section of the cable used is ·123 square inch.



A General View of Generating Machinery.

High-pressure mains run from the Manchester Street sub-station to smaller transformer stations throughout the town. There are at present five of these underground sub-stations at the following places :—

No. 1. Corner of High Street and Promenade.
No. 2. Corner of Cambray and High Street.
No. 3. Corner of Ormond Place and Promenade.
No. 4. Corner of Imperial Square and Promenade.
No. 5. Queen's Circus.

Nos. 1 and 4 are under the footway, Nos. 2, 3, and 5 being under the roadways. These sub-stations are large, being about 10 feet square by 10 feet deep, and access is obtained to them by a ladder through an opening in the centre of arch which has an ordinary sewer manhole cover with grid. The chambers have ventilator pillars on the corners of pavements about 4 feet high. The sections of such cables are either ·062 or ·020 square inch. As far as possible all the high pressure cables have been drawn into the lower ways of the conduit, but in places it was found most convenient to use an armoured feeder cable which has been laid direct under the street.

The total length of the H.P. sub-feeder cables drawn into conduits is 1,605 yards of 062, being mostly in the same streets as the low pressure network.

The armoured H.P. cables are laid in High Street and St. George's Place, the total length laid being 500 yards of ·029 square inch.

The whole of the distribution mains are of ·155 square inch section, and wherever it has been possible to do so the conduits have been utilised for their reception, armoured cables being employed only where the exigencies of the street work render this type of main most convenient.

The distributor network is laid in the following streets in conduits :—

Promenade from High Street as far as Imperial Square,
High Street from Cambray to Clarence Street,
Clarence Street from High Street to Manchester Street,
Monpieller Street,
Circus and Post Office Lane.

The total length of low pressure cable drawn in is 1,905 yards of 37/15.

Armoured distributors are laid around Winchcombe Street and Pitville Street, the loop being taken from the High Street distributors between High Street and Cambray Chambers, the total length laid being 365 yards.

The totals of the various cables are therefore :—

2,100 yards	37/16 H. P. feeder	in conduits.
1,905 "	37/15 L. P. distributor	"
1,605 "	19/16 H. P. cable	"
500 "	19/20 " "	armoured.
365 "	37/15 L. P. "	"
6,475		

Great care has been taken in jointing the cables, special boxes having been used, both in the sub-stations, at all branch points and opposite consumers' premises, which were also made by the Callender company.

The very high insulation readings obtained after the network was completed show that this jointing has been carefully carried out.

Consumers have been connected with the distribution network at pits constructed in the run of the conduit, in which cast-iron boxes are set, and from which double wire service lines lead into the consumers' premises.

A good idea of the distance and relation to each other of the transforming sub-stations will be gathered from the sketch, fig. 5. It is evident from this that some of the sub-stations are dependent on others, and that the whole are dependent on one feeder main. The distribution from the sub-stations, it might be mentioned, is done on a two-wire system.

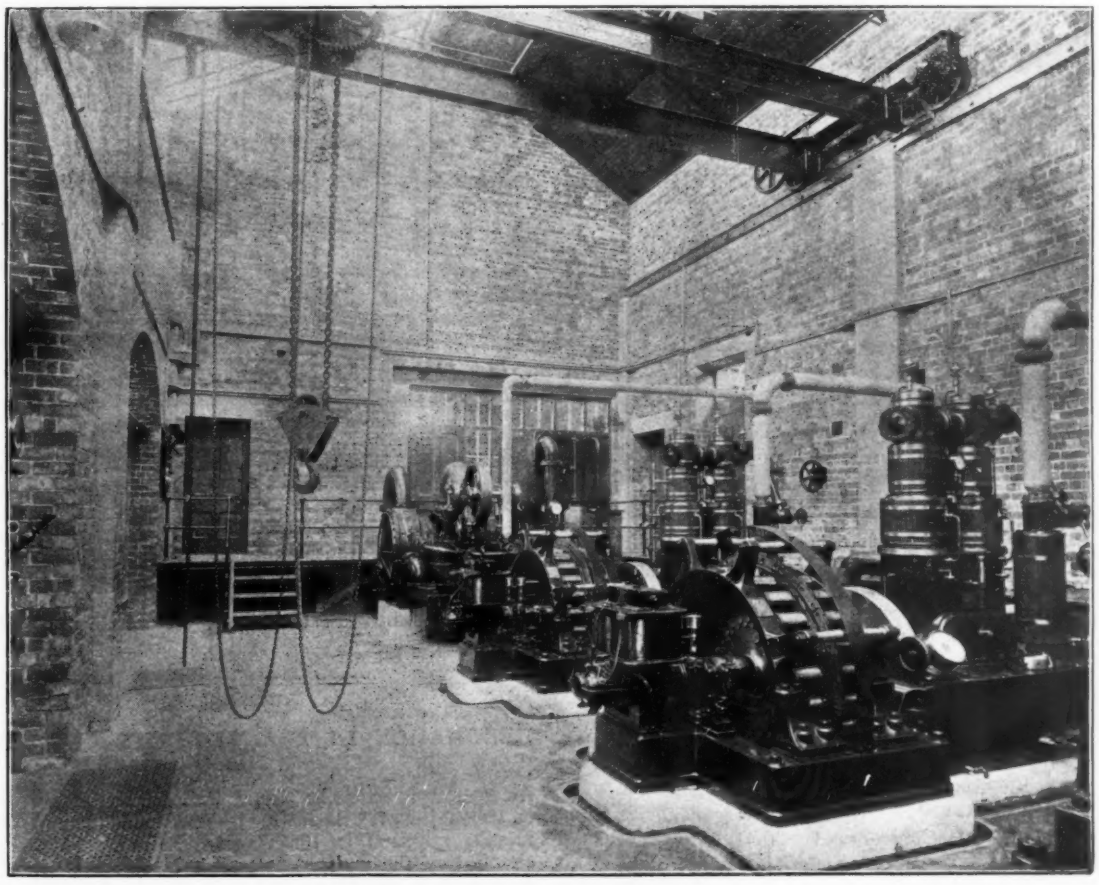
Mordey-Victoria transformers are employed in the sub-stations, while Johnson & Phillips's are used for the cases where house transforming is necessary.

Although we are not able to give complete detailed costs of the system, Mr. Hall has been good enough to furnish us with the following figures :—

	£	s.	d.
Cost of generating machinery, including erection	4,245	0	0
Cost of boilers, including installing ...	877	10	0
" cables for distribution	1,100	0	0
" buildings	2,300	0	0

In charging for current, the Corporation have effected some improvements, which are worthy of emulation. The most radical departure from usual practice is that of supplying meters free of charge. There is much wisdom in this. It has always appeared to us a most curious anomaly that rents should be charged for a means of measuring what is really a commodity. We are not forgetting the fact that supply systems have to spend a great deal on meters, but then this ought really to form part of the original cost of the system. The practice, too, of charging rents for transformers is one that is indefensible. Why a consumer should be compelled to pay rent for a piece of apparatus which is necessary, in virtue of the particular system employed, is difficult to understand. If it is held that on account of the capital expended on meters, &c., it is necessary to have some return, the rents charged ought not to exceed the sum needed to meet the interest. We will take a case in point. The St. Pancras Vestry have spent something like £3,712 on meters, but they charge for these a rental which represents 10 per cent. on the capital expended. They are therefore making a clear profit of 6½ per cent. on meters, which is not good policy. There is little to be said in favour of the retention of meter rents. They are a constant source of irritation to consumers, and after all form a small part of the income of a supply company. This is wandering a little from the main subject however. The price of electrical energy at Cheltenham will be 6d. per Board of Trade unit. Customers' accounts will be made up quarterly, and payments must be made at the municipal offices—5 per cent. discount for cash will be allowed on accounts paid within 21 days, and in case of non-payment within 28 days, the Corporation may refuse to continue the supply.

At the end of every municipal financial year, which is on March 25th, the total bill of every customer will be credited with rebates on a scale of which the following are examples :—

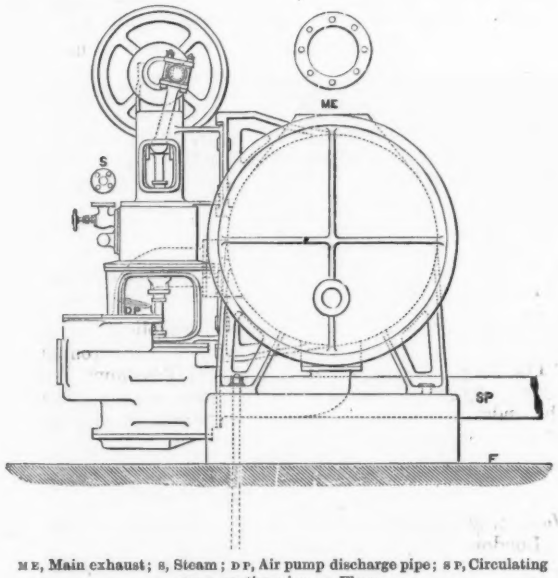


View of Small Alternators and Condensing Plant.

Greatest rate of consumption of energy in watts.	Rebate in proportion to the number of Board of Trade units taken during the year.							
	2½	7½	12½	17½	22½	27½	32½	37½
100	45	60	75	90	105	120	135	150
500	225	300	375	450	525	600	675	750
1,000	450	600	750	900	1,050	1,200	1,350	1,500
2,000	900	1,200	1,500	1,800	2,100	2,400	2,700	3,000
5,000	2,250	3,000	3,750	4,500	5,250	6,000	6,750	7,500
10,000	4,500	6,000	7,500	9,000	10,500	12,000	13,500	15,000

Intermediate values in proportion.

It will be seen that the system of charging is in many respects similar to what Mr. Wright has so successfully

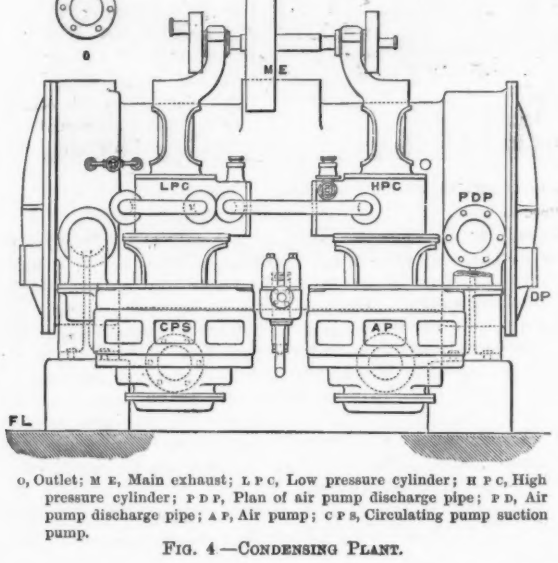


ME, Main exhaust; S, Steam; DP, Air pump discharge pipe; SP, Circulating pump suction pipe; F, Floor.

FIG. 3.—CONDENSING PLANT.

introduced at Brighton; indeed, we believe that the indicators in use at Cheltenham are of the Wright pattern.

We understand that since the works were opened, a little

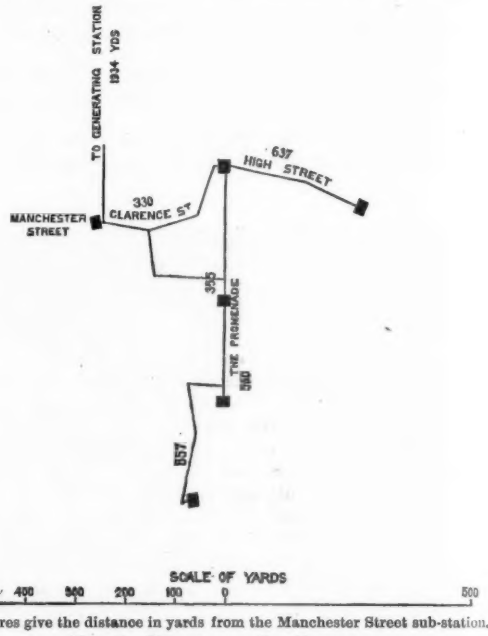


O, Outlet; ME, Main exhaust; LPC, Low pressure cylinder; HPC, High pressure cylinder; PDP, Plan of air pump discharge pipe; PD, Air pump discharge pipe; AP, Air pump; CPS, Circulating pump suction pump.

FIG. 4.—CONDENSING PLANT.

more than a month ago, a fair amount of lighting has been done, but we do not think that the members of the Electric Lighting Committee ought to be disheartened if the works do not pay their way during the first twelve months. The station was opened at the wrong time of the year to obtain many customers, but there is not the slightest doubt that the commencement of the winter season will bring a considerable load on to the station.

At the present moment there is no street lighting, but no doubt the importance of the matter will receive adequate attention at the hands of the Electric Lighting Committee. Cheltenham is to be congratulated on its Electric Lighting



The figures give the distance in yards from the Manchester Street sub-station.

FIG. 5.—POSITION OF SUB-STATIONS.

Committee. Under the chairmanship of Mr. Norman, and for a period under that of Mr. Ward-Humphreys, they have dealt with the introduction of the electric lighting into Cheltenham in a praiseworthy manner. For the information which we obtained during a recent visit, our special thanks are due to Mr. Norman, Mr. Hall, the borough surveyor, and to Mr. Franklin (Messrs. Siemens's representative), who has erected the plant and had charge of the running for several weeks.

RESONANCE IN TRANSFORMER CIRCUITS.

AN interesting article by Messrs. F. Bedell and A. C. Crehore on the subject of "Resonance in Transformer Circuits" has recently appeared in the *Physical Review*. In a single circuit (say the authors) resonance is obtained when, inductance and capacity being present, the resultant reactance is zero; that is, the reactance of the condenser used is exactly equal and opposite to the reactance due to self-induction. The natural period of the circuit then equals the period of the impressed electromotive force. Complete resonance is thus obtained when the impressed electromotive force varies harmonically. An effect corresponding to resonance in a single circuit may be produced by the reactive influence of one circuit upon another, occasioned by the mutual induction of the two circuits. This effect Dr. Pupin has called "consonance." The authors, in investigating the action of condensers with transformers, have come to the conclusion that certain of Dr. Pupin's deductions are incorrect—particularly his statement of the conditions under which consonance occurs, namely, when the apparent impedance of the primary circuit is either a maximum or a minimum.

The authors have conducted their investigations both analytically and geometrically, and by both methods they arrive at the same result. If I_1 = primary current, R_1 = resistance of primary circuit, C_1 = capacity of primary circuit, K_1 = reactance of primary circuit, J_1 = impedance of primary

circuit, and I_2, R_2, C_2, K_2, J_2 = similar quantities for the secondary circuit; then if R_1', L_1', K_1' and J_1' represent the apparent values,

$$E = I_1 \sqrt{R_1'^2 + K_1'^2}$$

$$= I_1 \sqrt{(R_1 + \gamma^2 R_2)^2 + (K_1 - \gamma^2 K_2)^2}$$

where E = harmonic electromotive force supplied to the primary circuit, and $\gamma = \frac{I_2}{I_1}$.

For the primary circuit

apparent resistance $= R_1' = R_1 + \gamma^2 R_2$

" reactance $= K_1' = K_1 - \gamma^2 K_2$

" impedance $= J_1' = \sqrt{R_1'^2 + K_1'^2}$

The apparent primary reactance equals the real reactance diminished by a multiple of the secondary reactance. The apparent primary resistance equals the real resistance increased by the same multiple of the secondary resistance. This multiple is the square of the ratio of the secondary and primary currents. The results are rigorously correct when the capacities and coefficients of self-induction are constant, and the impressed electromotive force is harmonic.

The conditions for consonance are readily obtained by noting the conditions under which the apparent reactance of the primary is zero, and it may be noted that while for consonance the secondary condenser decreases the apparent reactance of the primary to zero, it gives rise to a corresponding increase in the apparent resistance.

With reference to magnetic leakage, it is pointed out, as the result of the analyses, that the action of the condenser and of magnetic leak are opposed, and that magnetic leak may be thus compensated for. In fact, the secondary circuit may be given a capacity which will over-compensate for magnetic leakage; as a constant potential transformer is loaded, the secondary electromotive force may rise, despite the magnetic leakage drop and the fall in potential due to ohmic resistance.

A particular case of consonance, termed "pure" consonance, is obtained when the natural period of each circuit independently is equal to the period of the impressed electromotive force; the period of the system in this case being the same as the period of either circuit.

Finally, the authors point out that, by means of a properly proportioned condenser in the secondary circuit, if the secondary reactance be made zero (inside and outside the transformer), then simple secondary resonance is obtained, and a constant primary current will transform to a constant secondary electromotive force.

REVIEWS.

Problems and Solutions in Elementary Electricity and Magnetism. By W. Slingo and A. Brooker. London: Longmans, Green & Co.

The contents of this book are solutions to the South Kensington papers on electricity and magnetism for the years 1885—1894. Whether the answers given would satisfy the examiners who set the questions cannot be decided, as no two examiners would be likely to hold the same views on the subject. Personally, we think that Messrs. Slingo and Brooker have come out very creditably, and may be considered as having passed with honours. The authors are not, however, always happy in what they say; for instance, on page 93, they give the following answer to the question, "How would you prove that glass and silk, when rubbed together, are equally and oppositely charged?" "The simplest way of proving this is to first thoroughly insulate the silk rubber from the hand by holding it in a sheet of India-rubber, or by wearing an India-rubber glove. The silk and glass having been electrified by friction, should then be placed together on the cap of an electroscope, and it will be noticed that no divergence of the leaves is produced. If, however, either the glass or the silk be removed, the remaining substance causes a divergence. That the two bodies are electrified is therefore proved, and the fact that no divergence results when both of them are present proves that they were equally and oppositely charged." Now, with reference to this experiment, what would be the result of placing two oppositely electrified bodies on a metal plate (the cap of the electroscope); the effect would be that the two bodies would discharge one another, in which case the after removal of one or other of the bodies would produce no effect, since there can be no charge remaining in either. It is difficult to see why the authors have departed from the old orthodox proof, which is none the less good because it is old, viz., to first charge the electroscope, and then to bring first one body and then the other body near to the cap; this, in one case, producing an increase in the divergence of the leaves, and in the second case a decrease. Even if the experiment were made as described on page 21, it would be much more reasonable than the one we object to.

In looking through the various questions (for which, of course, Messrs. Slingo and Brooker are not responsible), one is struck with the rather undue proportion dealing with the phenomena of magnetic needles. Such phenomena are not of particular value, nor are they very suggestive. It is, however, by no means an easy matter to frame suitable questions for examinations. At the end of the book a number of original questions are added. Answers to these might with advantage have been included, and it would have greatly added to the value of what is undoubtedly a very useful production.

Journal of the Institution of Electrical Engineers. No. 115. London: E. & F. N. Spon, 125, Strand.

The chief contents of this number are as follows:—"Inaugural Address" of the President (Mr. R. E. Crompton); "The Origin and Development of the Telephone Switchboard," by J. H. Kingsbury. With this number is issued the index to Vol. xxiii., and also a revised list of members of the Institution.

Journal of the Institution of Electrical Engineers. No. 116. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—Papers on "Reversible Regenerative Armatures and Short Air-Space Dynamos," by W. B. Sayers. "Propagation of Magnetisation in Iron," by Dr. John Hopkinson.

Catéchisme D'Electricité Pratique. Par Ernest Saint-Edme. Paris: Bernard Tignol, 53, Quai des Grands-Augustins.

The author of this book was formerly Professor of Physics at the Ecole Turgot. The work consists of a series of questions to which corresponding answers are given at length. In fact, it is an elementary treatise on electricity with headings in the form of questions. In answer to the question, "What is the ohm?" it is stated that it is represented by a column of mercury 1 square millimetre in section and 106 millimetres long. It is difficult to understand why the author could not have given the correct value, viz., 106·3, instead of the rough approximation only. The fig. representing the Wheatstone bridge is decidedly not a suggestive one; in fact, is not at all a suitable explanation of what a bridge is. Many of the figs. illustrative of various electrical apparatus are very antiquated, and altogether the work is not one which produces a very favourable impression as to its utility, although it possesses some good points.

Funk & Wagnall's Standard Dictionary of the English Language. 2nd vol. Funk & Wagnall's Company. London: 44, Fleet Street.

This second volume completes the issue of this fine work, which has a vocabulary of 300,000 words, contains 2,338 pages, 5,000 illustrations, and has cost nearly a quarter of a million sterling to produce. It is almost unnecessary to say that the whole work is a masterpiece of its kind, and will doubtless long remain so. No pains have been spared to make the volumes as complete as possible, and although in-

evitable slips may be met with here and there in the pages, yet accuracy is a distinctive feature of the production. We might devote much space to calling attention to the many excellent features which the volumes possess, but we should hardly emphasise the good opinion, not to say admiration, which we, in common with others, must have for the work. We can only say that those who require a really good dictionary should purchase the two volumes, which at $12 (for the single volume edition), and $22 (for the two volumes bound in full morocco), are decidedly inexpensive.

Extracts from the Private Letters of the late Sir William Fothergill Cooke, 1836—39, relating to the Invention and Development of the Electric Telegraph; also a Memoir by Latimer Clark. Edited by F. H. Webb, Secretary Inst.E.E. London: E. & F. N. Spon, 125, Strand.

To all members of the profession of telegraph engineers this collection of letters should prove of very great interest, for it is a faithful record of the struggles of a man who clearly foresaw the great future that the electric telegraph had before it, and who, with indomitable perseverance, was determined to make a success. There are forty-five letters in all, in the series, some brief and only alluding to the subject of the telegraph, but forming connecting links. The memoir by Mr. Latimer Clark, which is included in the book, was originally published in the *Proceedings* of the Institution in 1879, and forms an appropriate appendix.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on Mr. Mark Robinson's Paper.

The President, after proposing a vote of thanks to Mr. Robinson, said he need hardly call attention to the extreme and paramount importance of this question of the development of the high-speed engine to those who were electrical engineers and power generators on a large scale. He thought their great progress dated from the time when Mr. Willans began to pay such close attention to the high speed engine, and that fact should be the warrant for the paper that had been read that evening. He hoped, after Mr. Robinson had acted in such a self-denying manner by cutting his paper down to a mere abstract, that the discussion would be worthy of the paper, and that they would be able to spend the remainder of that meeting, and the whole of another, in the discussion of it.

Mr. J. S. Raworth said they had had a very great treat that night, because they had heard a gentleman read to them a paper on a mechanical subject who was evidently not only a good engineer, but also a master of the literary art. Some of them did not pay quite enough attention to this matter of finishing off their papers. Mr. Robinson had not only chosen melodious words, but had gathered them together in a harmony of composition. He quite agreed with the words they had just heard from the president, that the electrical industry owed a very great deal to Mr. Willans for bringing before them this wonderful engine, because it enabled electric lighting to be introduced in its early stages, under circumstances in which, perhaps, no other engine could have existed. He did not, however, quite agree with the president in suggesting that electricity would not have advanced so rapidly but for this engine, although it was quite possible that it would not have advanced so rapidly within the confines of the London postal district but for the work which Mr. Willans had done, and of which he had given them the benefit. While he (the speaker) did his work with other kinds of engines, he must say he was a great admirer of enclosed engines, and he did not think all the advantages claimed by Mr. Robinson for the Willans engine came from the fact that it was a single-acting engine, but accrued from the fact that it was an enclosed engine. They had at the top of the paper the title, "The Recent Development of the Single-acting High Speed Engine for Central Station Work," and he rather imagined that when Mr. Robinson took that title, he was going to give them a history of the development of the single-acting engine; but the paper itself was confined, so far as he understood it, to the recent developments of the Willans engine, and the author had not thought fit to go back to the early history of the Willans engine; there were many single-acting engines before the Willans engine, and even the Willans engine itself went as far back as 1874. At that time it was a very common place contrivance, simply a three-cylinder arrangement, in which one piston acted as a valve for the other cylinder, and so forth in the three piston train, whereby he got the advantage of doing away with separate valves. That engine was practically of little use except for driving launches. It was very nearly the same as the Brotherhood engine, if the three cylinders had been put in a line, and he (the speaker) could remember when Brotherhood's had a great run for supplying engines for driving dynamos, and he thought Mr. Willans got his stimulus from that fact, put his brains to work, and discovered the central valve principle, whereby he made not only a quick running, but a thoroughly economic engine. He did not want to develop that point of his remarks, because there was a great deal to be said on the subject, but to direct attention to the second paragraph, in which Mr. Robinson said that a certain paper stated that if they "had stuck to the builders of mill engines and marine engines, instead of trying to strike out a new line of steam engines for themselves, electric lighting would have been very much the gainer." He (the speaker) quite agreed that that was all nonsense. The author said further down that the total indicated horse-power installed in all the lighting stations in Great Britain was 101,390, and of this his firm had made 53,340. Well, the Brush Company had built 31,000, so there were only about 17,000 left. He did not know whether either of them was exaggerating, but he would take it for the moment that both were speaking the truth. This fact remained, they had not been greatly indebted to mill engineers. He would undertake to say that there was no one in that room engaged in this industry who had not at one time or another tried the effect of consulting one of those engine builders. His experience had been that they had failed entirely to grasp the situation. They knew how to drive a mill, but it was quite another thing to turn out an engine to drive an electric dynamo which responded to every touch and reproduced the fluctuations of the governor with absolute accuracy, and which had not got the steadying influence of 200 or 300 horse-power in mill shafting. He had the privilege the other day at Leicester of meeting Mr. Hudson, and he was talking over the engines with him. Mr. Hudson acknowledged the difficulties they were under, and said there was not a mill engine in Lancashire that would do the job they were inspecting. There was a wave of opinion going over the country to the effect that small high-speed engines were merely temporary expedients, and that if they wanted something permanent and substantial, they must get a horizontal slow-speed engine. He was quite sure he would have their concurrence in the statement that it was nothing of the sort. If that argument were correct, that the slow-speed horizontal engine was a permanent thing, was a thing for which a corporation might pay out the funds of the ratepayers, and which they might expect to see there in goodness knew how many years after, all he had to say was, that that argument would apply equally well and more so to the good old beam engine. When he was an apprentice, the same battle now going on between the horizontal slow-speed and the vertical high-speed engine was being waged between the beam engine and the horizontal. Instead of the horizontal being the respectable, hoary-headed old rascal it was at the present day, it was the new comer, the cheap thing, the article you put down without much foundation, but that thing which was pointed to as the real practical, satisfactory article, was the beam engine. He had no hesitation in saying that if the horizontal engine lasted 40 years, the beam engine would last 80 years, and if corporations in trying to save pence or pounds of their ratepayers, did not mind spending a good many more pounds in interest on money and depreciation, by all means let them put in a beam engine instead of a horizontal, and get one to last to all eternity. Coming back to the Willans engine, he was, as he had said, a very great admirer of that contrivance; he thought it had extremely good points. He had used some with very great success. Mr. Robinson had put its features most admirably; giving them some idea as to its engineering construction, and the theory followed out by its makers, of which they were entirely ignorant before. This ingenious engine had one difficulty, and engineers would look on it as a serious difficulty, that was that it was a Chinese puzzle, and they could not afford to keep a Japanese always on the premises to solve the problem. When he said it was a Chinese puzzle, he meant that they could not take out any one portion to see whether that part was in proper order or not. If he desired an illustration of that remark, he would refer them to that charming picture which Mr. Robinson had supplied to the paper, in which they would notice a central column nearly as big as the Eiffel tower. The fault of the Willans engine was that they had to take down the whole of that pillar in order to get to the bottom piston or gland. On the subject of complication, he would like to repeat a conversation he had some years ago, which, if published, would be one of the finest testimonials Messrs. Willans and Robinson ever had. He was trying to discuss the Willans engine with a distinguished member of that Institution, a gentleman who had had a large number of those engines, and he said "No, Raworth, I really do not know what is inside a Willans engine." He never told a bigger story in his life; but he said, "I know there are three holes in it, one where the steam goes in, another where the steam goes out, and another where you put oil in. If you pay proper attention to those holes you will have no trouble" (laughter). Mr. Willans's engine never received a higher compliment than that. If he might illustrate the matter a little further, he would tell them a little anecdote of one of the railway men in America who was trying to induce a tramway company to accept an electric car, and was met with the remark that an electric motor was far too complicated for them. His reply was, "If that is too complicated for you, it must be pretty complicated. Cut open your horse and see what is inside that." The Willans engine had the advantage of the horse in that respect. Now, he wanted to take them for one moment to the question of high speed. Mr. Robinson seemed to think that the speed of revolution was a natural corollary from having the thrust entirely in one direction, and he found that a great many people were carried away by the same specious argument. He would ask them to consider that a Willans engine giving 360 H.P. had only a stroke of 9 inches. Now, did anybody ever see a double-acting engine with anything like so small a stroke for that high power? In his experience there never was such an engine. He noticed with considerable satisfaction that Mr. Robinson admitted that for the extremest speeds they must use a double-acting engine. The reason was obvious, because on the back stroke they had to put velocity into the working

parts out of the cranks, and not out of the steam, and the strain would become excessive. Now they found the question of wear discussed, and he was sorry to say he could not quite agree with the author. In clause 7 he said: "It is evident that a single-acting engine, in which there is absolutely no back-lash, and no reversal of stresses, and which is otherwise rightly proportioned, will run freer from wear in its brasses than a double acting engine at any but very moderate speeds." He was quite willing to admit that the Willans engine was pretty free from wear, but he did not attribute it to that cause. He had had large experience with bearings run with considerable weights pressing entirely in one direction. They had manufactured, by the Brush Company, a Mordey Victoria alternator, and that machine had a magnet which weighed a considerable number of tons, and it was always a very great difficulty to get the bearings of that machine to run at all. At the high speed of the old belt-driven machines, it was difficult to get it to run until they adopted forced lubrication. They were very much surprised to find that bearings which ran at 500 lbs. per square inch in an engine, when applied to that dynamo would not run it at 70 lbs. per square inch. By changing over the strains when the engine piston passed over the stroke a gap was made, into which the oil could freely enter, and it gave them the opportunity of getting better lubrication than they could get with the journal with constant pressure in one direction. He would pass over the features of special interest which Mr. Robinson had given them, and which he very highly appreciated; he thought they were very much to be admired, and the firm should take great credit for the improvements which they had introduced since the loss of Mr. Willans. But he did wish to refer to one point which he had had out once before, either with the president or Mr. Robinson, and that was the question of brake efficiency. The Willans people had always claimed for their engine a higher brake efficiency on the average than they said could be obtained with ordinary engines. He (the speaker) claimed that the ordinary vertical engine properly constructed would not only run with the same efficiency, but a higher one. They did not often make tests of these things, but in this case they had had an opportunity of getting a definite result. It was in connection with the engines for the City of London, which were tested by Prof. Kennedy. The combined efficiency of the two, engine and dynamo together, was 83 per cent. He was quite sure that Mr. Mordey did not claim for that dynamo more than 90 per cent., and if he did not claim it they might be quite sure it was not there. That brought out the engine at 93 per cent. efficiency. He asserted that any ordinary Tangye engine which they could buy out of a shop window would give from 90 per cent. upwards in brake efficiency. With the slow running horizontal engines which were so much admired, he quite admitted they could not do it, because they had to drag forwards and backwards on a long rail with no wheels a heavy piston with imperfect lubrication on it. This it was that reduced the break efficiency of the horizontal engine. He heartily agreed that electrical engineers were greatly indebted to Messrs. Willans & Robinson for the specially highly developed machines which they had put in their hands for getting over the difficulties of many very awkward conditions.

Mr. W. H. Booth said there were one or two remarks he would like to make, and particularly one with reference to the Cornish cycle. The author referred in the paper to the overlapping of the temperature ranges in the cylinders of an ordinary engine, stating that that was not the case with the Willans engine. He did not think the reference to the ordinary engine quite correct and exhibited indicator diagrams showing how an ordinary compound engine with badly arranged valves would have an exhaust line sloping downwards in the H.P. diagram, and how this could be remedied by earlier closing of the L.P. steam valve and a storing up of the steam in the receiver, raising the back pressure in the H.P. cylinder and preventing any overlap of the pressures and temperatures. This was a point which ought to be insisted upon in compound working. He admitted the value of the Cornish cycle but thought the ordinary compound and triple engine obtained the same result in this respect in all but the last cylinder, as could be obtained in a single-acting engine.

Mr. E. Tremlett Carter said the cylinder condensation depended on the temperature fluctuation of any particle of the iron. What Mr. Robinson had shown was, that in the Cornish cycle the fluctuation of the temperature at any one stage of the piston was divided into two, but the fluctuation of the temperature of any particle of the cylinder line was really continuous, as if the whole expansion took place in one stage. His point was, that the two stages of the fluctuation of temperature did not take place in two separate cylinders with two separate surfaces, but in one cylinder and one surface. Every particle of iron underwent two changes of temperature, and the variation of temperature of iron caused the condensation of water on the surface just the same, whether they had a Cornish cycle or whether they had an ordinary expansion in one stage.

Colonel Sale spoke as to the relative cost of these methods of driving. Recently he had had occasion to call for tenders on the part of the Government for certain engines and dynamos to turn out 500 horse-power, the dynamos to be direct driven. The question lay between slow speed engines and fly-wheel armatures, and a comparatively quick speed engine driving a multipolar dynamo somewhat larger than the engine, and a high speed engine driving, of course, a comparatively small dynamo with comparatively high speed. The low speed engine ran at 80, and the speed of the dynamos was 120. The speed of the high speed engine was not specified. It would be supposed that far and away the cheapest would be the high speed engine and dynamo, both being comparatively small, but that was not the case. The highest price, but not much the highest price, was that of the slow speed engine and the armature fly-wheel; next in order came the high speed engine and the high speed dynamo together; the lowest of all was the vertical engine and the multipolar dynamo running at 120. This result was contrary to expectation.

Discussion on Mr. Robinson's Paper, May 23rd.

Mr. Alexander Siemens said it was a singular coincidence that that day was the anniversary of Mr. Willans' death. He should not have risen to occupy their time if Mr. Robinson had not mentioned his (Mr. Siemens') Newcastle paper. With regard to the figures given in that paper he would remind them that they were not test figures for short trials, but they were the results obtained in the regular working of their central station in Woolwich. As to the results obtained by the Belliss engine, he would specially observe that that engine was the very first of its kind made by Messrs. Belliss, and it was only natural that later engines should show better results than the one about which he reported at Newcastle.

Mr. Chandler said there were one or two points in Mr. Robinson's paper, with which he could not quite agree. Firstly, he told them, the valve rings were not steam packed; that was the slide valve rings. Now, if they were not steam packed what prevented them from collapsing during the transit past the portholes in the trunk? It would appear pretty certain that there must be considerable pressure within the inside of the rings or leakage would take place and reduce the splendid economy of the engine. It would be most interesting to all advocates of piston valves to know what really were the conditions of pressure at the back of the rings. Then again they were told that steam was admitted to the space behind the piston rings, and this steam assisted by the thin junk ring or "follower" kept the rings in constant thrust downwards. This, of course, was so. But the same conditions were arrived at with the old-fashioned piston which was illustrated on the black-board, and that they would see was an extremely old-fashioned one. They would suppose that piston to be single-acting. The rings should not wear the cylinder walls any more than the Willans or any other single-acting engine having the same steam cycle, or it should not wear the periphery of its own rings, any more than a Willans engine, seeing that both have steam pressure behind them and also on the top. The cause of longevity of the cylinder and rings in single-acting engines was the fact that only during the down stroke were the rings exerting great pressure on the cylinder walls, therefore wear was taking place during only half the revolution of the crank. Thus, if the piston speed happened to be 500 feet wear was taking place only over 250 feet of it; this applied to the engine with which his (the speaker's) name was connected and which had precisely the same steam cycle as the Willans engine. The white spaces at the back of the black ring in the diagram would represent the steam space, and the piston was supposed to be very much worn or a very loose fit in the cylinder, therefore steam was on the top of the piston ring and at the back of it, forcing it outwards and downwards, thus causing a comparatively steam tight joint. During the up stroke the piston would force the ring upwards and when it got near the top centre compression would still keep it downwards until the new steam entered and forced it still harder downwards on to the bottom flange of the piston. He had known an old and badly worn engine working under those conditions. He simply mentioned this to show that not only could the most modern engine accomplish these things, but also the most ancient.

Mr. Malcolm said he was rather at a loss as to the manner of his reply to Mr. Robinson's paper, as the latter had referred so extremely politely to the Belliss engine in three or four points; but it had been pointed out to him that the whole tenour of the paper would be certainly to condemn it quite as much as any of the other engines to which Mr. Robinson had been referring. Now, he might say they had proved certainly that in all the points to which Mr. Robinson had referred they had an engine at least as good as the Willans. He would prove his words further on; but it would be useful to deal with the matter historically in the same way as Mr. Robinson had done and show why their engine was designed. They had been building high-speed engines running up to quite as high revolutions as the present electric lighting engine, 500 and thereabout, for all kinds of powers, for a matter of nearly thirty years, so they knew what a double-acting engine could do, and they knew what it could not do. When they were brought face to face with the necessity of devising an engine that would run continuously for station work at the higher speed of revolution—because the dynamos and the size of the engines handicapped them—they naturally looked to the single-acting engine as a possible means out of the difficulty. They were building then for the Navy, and their first view in that direction and the things they saw as far as single-acting engines went at first discouraged them. He did not want to say anything to annoy Mr. Robinson, but would simply refer to the facts as they were; and Mr. Robinson in his reply would doubtless say that which would help his view. The engines were for electrical purposes in the Navy. Some years ago those engines were nearly altogether single-acting engines, but the Admiralty, owing to the difficulties occurring with the single-acting engine, permitted double-acting engines to be employed at the same time, but would not permit them to run at more than half the number of revolutions. Gradually representations were made as to most serious collapses of the Willans engine, lines of valves coming down, crank shafts breaking, and pistons smashing altogether. He would not answer for this, but he had heard it from an officer in charge of one of the foreign yards that they were not able to repair Her Majesty's ships in the proper way as the Willans engines took up so much of their time. That might be exaggerated; but the fact was undoubted that at the present time the Admiralty, and also a number of other Governments, would not have a single-acting engine for driving the electric light. Double-acting engines had been going through the same duties alongside of them and had not shown the collapse and difficulties. His firm started with that before them, and they had to consider what their double-acting engine was doing without forced lubrication, and what it might do with a system of good lubrication. They then made the arrangement as they now had it, that was pumping oil to every bearing of the engine, keeping it there under pressure, and letting it work out its benefit in its own way.

The benefits derivable were, in the first place, in regard to durability, and, in the second place, in regard to economy. But the point they wanted to look at was, taking the single-acting engine as it stood, as compared with the double-acting engine, there was always the fact that you had twice the area of piston; that meant double the strain upon each rod, double the pressure on every bearing, and, therefore, under ordinary circumstances, double the wear. In addition to this, the mode in which the pressure was taken, the constant thrust which Mr. Robinson had referred to as being a favourable feature in the engine—this constant thrust had been a thing he had had some experience with in the oil-testing machinery at one of the dockyards. There they had an arrangement made with a half brass grasping a journal running underneath it, and the oil to be tested was let through the upper part of it. They had this thing with a dead weight put on, so that it was just the same as in the Willans engine, a dead thrust on the bearing. Marine engineers knew that the thrust of the engine was a thing to be looked after. In the oil-testing machinery they had *this* (indicating) brought down on to the journal as in the Willans type and oiled it there. They could never get that thing right until they had a thing *here* to jig it up, and act like a double acting engine as a matter of fact. Then it kept right with a tenth part of the oil. This helped them along to go boldly into the design of a double-acting engine, knowing that they were going to get somewhere near if not up to the Willans engine. Well, they had designed the engine and it was there for good or bad to be compared with Messrs. Willans's engine, and he would now just take up the points Mr. Robinson had referred to, one by one, and see how they had fared. First came the question of economy. He had there the results of a trial of one of a set of engines for St. Pancras, recently made under conditions very parallel with those obtaining at Thames Ditton. In fact, they had copied their testing arrangements as exactly as they knew how to do. The tests were made in the presence of Professor Robinson's assistants, four gentlemen who were looking very keenly after them, and he had no doubt they were all right. There were, in fact, three engines of the sort, and a comparison between the three showed that the results were practically correct as they stood. They had there certainly as good an engine as they could make at the present time It showed that with pressure of steam about 120 lbs., the water per E.H.P had come out to a mean of 19·89 for an average of six hours' running under full power. The power that they ran the engine at was about 109, higher than the maximum required at the station, an extra full power required occasionally. As the slide valves were set for that, they preferred to run at that power to get the best possible result. That result was as good as the Willans engine could do with that pressure of steam. Taking the dynamo efficiency at 96, which the makers gave it at—and he should say from the magnificent way in which they ran that they were well worth that efficiency—the efficiency of the engine came out at 92, the higher figure which Mr. Robinson had spoken about. Now, they had had a number of other trials before different gentlemen, but they had not been able at present to have the trials in the same way as at Thames Ditton, but they hoped they would be able to when their new test houses were built. There was no doubt about this fact, that there was not a halfpenny between the two engines so far as economy went, and they might take his word for it that there was at present no use paying any more for it. As far as durability went, Mr. Siemens had referred to the engine that was spoken about at Newcastle. That, of course, was one of their first engines; he wished, seeing the position it was in, that it was one of their last ones. With regard to economy that engine seemed to be to some extent against them, although it showed up better for light loads, whilst the Willans was better for high loads. But in that engine at the time when the experiments were made they had a two-crank engine, with cranks opposite, as against a Willans and Robinson three-crank engine. The question of vibration came in, and undoubtedly the three-crank was better there. They had, as a matter of fact, to put on an exhaust lap to quiet the engine down. The amount made the back pressure on the low-pressure cylinder so great that the diagram showed only about 4 lbs. and a decimal. The diagrams recently taken, since the engine had been put right and the lap taken off, showed 9 lbs., a matter of 4½ lbs. there which would have brought the engine up to and beyond the Willans and Robinson engine for full power, whilst it largely beat it for small power. The question, of course, there was certainly dependent upon the serious amount of friction there was in the numerous rings of the Willans engine. There was no use comparing the parts of the engines as they existed at the trial made at Messrs. Siemens's works, but the parts of the Willans engine were far and away more numerous; the rings were greatly more numerous, and he thought Mr. Robinson put his finger on the reason why their (Messrs. Belliss's) engine showed up better on the lower loads. But that question of piston ring friction was a big question, and was going to be a bigger one by-and-bye. At the present time super-heating was largely in the air, and he thought he should be willing as an engineer to predict that in the next year or two super-heating would be very largely employed in electric lighting stations. If super-heating came in the question of rings and the friction they might have would be a very different thing from what it was now. The necessity for lubrication would be of importance, but there would also be, if water-tube boilers came in, the necessity of keeping that lubrication out of the boilers. With condensing and super-heating the Willans engine would stand still a worse chance. He was saying all he could—of course, all he knew, and perhaps he did not know all—in favour of the double-acting engine, as against Messrs. Willans's engine in particular. As far as governing went, one would say off-hand that the double-acting engine ought, having two impulses in the revolution, to be better than the single-acting engine for governing, but he had seen some single-acting engines where it had been necessary to throw the governors out and govern the station by means of a man at the throttle. He thought Mr. Robinson had pointed out the impossibility of a double-acting engine doing as well as a single-acting engine as far a governing went. They had had bad governing, because they had not taken a great deal of trouble to bring down the friction to what it could be brought. During the last three months they had turned their attention to that, and Mr. Preece, if he were there, could say, from what he had seen at their works, that he had not seen the present governing excelled by any single-acting engine. The governing was isochronous, and when the load was thrown off from full load to nothing the run up, the great point they were trying to avoid, with all the load thrown off, only amounted to about 3 per cent. They did not want better governing than that. In fact, he might say the double-acting engine governed quite well enough. They had attacked the problem of endeavouring to stop the vibration in the central stations of London, and he thought they would do it yet. The engines put in, although they had a rocking movement, did not have an up and down thrust, and it was the latter, of course, that was of the greater importance, on concrete at any rate. Mr. Robinson's diagram, fig. 14, showed very well the alteration they were going to make in their endeavour to put right the matter of vibration. An engine which was coming back to them, to be replaced, he was sorry to say, by one of Willans's, was to be modified in that way, and they would see what they could do with it. If it did not answer they had at least a three-crank double-acting engine, and there was no reason why, at equal angles, it should not be, as far as vibration went, as good as the single-acting engine. There was nothing in the single-acting engine to give a benefit there. He had been obliged to speak out as he had done, because their engine had been for a long time behind the scenes and people did not know them. Messrs. Willans were to the front, and had done excellent work; they had supplied a want when the demand was made, and they were earning their reward. If Mr. Robinson had left his engine alone he should not have risen to speak, but Mr. Robinson had spoken and he must answer. He felt satisfied with his answer, and was content that the engine should rest on its merits and make its progress by its merits. He hoped his remarks about the Navy would not be believed to have been made in bitterness of spirit. There they had engines put together in a place where, if they did not get the same attention as they would get in a central station, they, at least, got as much attention as others, and if they were taken out and replaced by double-acting engines it showed that the latter were better. The engine which was taken out at Messrs. Siemens had run for two years and the bearings were not altered; there was no wear, and no adjustment had been necessary. In the case of the engine taken out of the station on account of vibration, to be replaced by a Willans engine, the gentleman in charge of the station, who was as impartial as anybody could be, had thought it his duty to send them a letter stating how much pleased he was at the way in which the engine had opened up. They had done absolutely nothing to it and it was in as good condition as when put in. Where was the quality in the single-acting Willans engine that could make it better? Theirs had been only about three years in the market; it had gone through its childish troubles and had had its little difficulties and now they had an engine far more perfect than it was then, and though it was impossible to challenge Messrs. Willans and Robinson to a public trial he should be glad to have a public trial on the lines of that conducted by Mr. Siemens to satisfy electrical engineers that they had another engine that would do them good service.

(To be continued.)

Physical Society.

ORDINARY MEETING, MAY 10TH, 1895.

Captain W. DE W. ABNEY, President, in the chair.

Mr. HERROUN read a paper on the "IODINE VOLTMETER."

After referring to the usual methods of determining the value of the small currents used in calibrating galvanometers and other apparatus for measuring small currents, and discussing the errors to which they are subject, the author gave his reasons for selecting iodine. He did this since with the exception of mercury in the mercurous state, iodine has the largest electro-chemical equivalent, and, in addition, by titration with sodium thiosulphate it is possible to determine the quantity of iodine liberated with a greater accuracy than can be obtained by weighing a deposit of copper or silver with the balance. The solution employed in the voltameter contains 10 to 15 per cent. of zinc iodide. If care is taken to leave a small piece of metallic zinc in this solution no free iodine is liberated on keeping, unless the solution is exposed to a strong light for some time. The anode consists of a plate of platinum at the bottom of a tall and fairly narrow beaker. The wire leading the current to the anode is incased in a glass tube so that the iodine is only liberated at the bottom of the beaker, where, on account of its great density, it tends to collect. The cathode consists of an amalgamated zinc rod which, to prevent loose particles of zinc falling down into the iodine, is surrounded by a piece of filter paper or vegetable parchment. In an electrolysis lasting for as long as two hours none of the iodine is found to diffuse up to the part of the solution near the zinc cathode. Where, on account of the extreme feebleness of the current employed, it is necessary to allow the electrolysis to continue for longer and have two hours, a U-tube is used with two small plugs of asbestos at the bend, the anode being in one limb and the cathode in the other. With this form of voltameter, even after the current has flowed for several days, no signs of iodine have been found in the limb containing the cathode.

On account of the production of electric convection currents, the iodine voltameter does not seem to be quite so suitable for accurate measurements of strong currents. After the current is stopped the zinc electrode is immediately removed, the solution stirred, and the

amount of iodine liberated determined by titration with sodium thiosulphate. The author finds that a convenient strength of the thiosulphate solution is one in which 1 cc. corresponds to the amount of iodine liberated by 5 coulombs of electricity. This solution contains 12·8375 grms. of pure recrystallised sodium thiosulphate per litre. It is possible to perform the titration to within 0·1 cc., which corresponds to 0·5 coulomb, or if the electrolysis lasted one hour, to $\frac{1}{7200}$ ampère. In a comparison made with a silver voltameter, the current as deduced from the silver was 0·0264 ampère, and that deduced from the iodine 0·0266. The author considers that part of the difference may be due to the effect of oxygen dissolved in the solution of silver nitrate.

Prof. Carey Foster considered this process for measuring currents a most valuable one. The idea of using a volumetric method for measuring currents was to him new. He did not, however, see the advantage of using a substance with a high electro-chemical equivalent if a volumetric method was going to be employed to estimate the quantity of the substance liberated. It would be possible to use a chloride, though in this case the titration would probably be less accurate.

Prof. Silvanus Thompson said he thought the method would be very valuable, but he would like to know if any error was likely to arise if too great a current density was employed. The number the author had assumed for the atomic weight of silver (108) was only approximate; if the more accurate value 107·7 were used, the agreement between the results obtained with the silver and iodine voltameters would be improved.

Mr. Trotter asked what was the largest current that could be accurately measured.

Mr. Enright said he had used porous diaphragms in iodine voltameters and found that the iodine collected in the positive compartment while the water was driven over into the negative compartment. With strong currents it was possible to get almost pure iodine left in one compartment.

Mr. Watson thought that since the value for the electro-chemical equivalent of iodine used by the author was deduced from Rayleigh's value of the electro-chemical equivalent of silver and that Rayleigh's experiments were performed in air, the difference obtained with the silver and iodine voltameters could hardly be due to the cause suggested.

Mr. Elder warned the members that volumetric measurements were not so accurate or easy as they seemed. He particularly mistrusted a solution of sodium thiosulphate, since he had found a solution of this substance to change even in 24 hours. The difficulty of accurately reading the burette might be overcome by weighing the burette and its contents before and after the titration.

The Author in his reply said that with the size of electrodes he used (about 9 square cm. surface), 0·1 ampère was the maximum current it was safe to use. The only substance likely to be produced by too great a current density was periodate, which, since it was insoluble, would immediately be noticed. The influence of the dissolved oxygen was only appreciable with small currents where the electrolysis lasts some time, while in Rayleigh's experiments large currents were employed.

The Chairman, while returning thanks to the author for his paper, mentioned that in his experience he had found zinc salts to be very untrustworthy.

Ordinary Meeting, May 24th, 1895.

Captain W. de W. Abney, President, in the chair.

Dr. Kuenen read a paper entitled "On the Condensation and the Critical Phenomena of Mixtures of Etheine and Nitrous Oxide."

Mr. Burstall commenced the reading of a paper "On the Measurement of a Cyclically Varying Temperature."

The experiments were undertaken with a view of measuring the temperature inside the cylinder of a gas engine at different points of the stroke of the piston. A modified form of platinum thermometer is employed to measure the temperature, and since the variations in temperature are extremely rapid, the wire had to be very thin and unprotected by any covering such as is ordinarily employed. The leads of the thermometer pass through a slate plug fixed in a seamless steel tube, asbestos being used as a packing to prevent leakage. The resistance of the thermometer was measured by means of a Wheatstone bridge. Since the temperature at a certain part only of the working stroke had to be measured, the galvanometer circuit was broken in two places, one of these breaks was closed by means of a cam on the shaft of the engine at a given point of each revolution, while the other was closed when an explosion took place by means of a relay worked by the pointer of a steam engine indicator attached to the cylinder of the engine. The remainder of the paper was postponed till the next meeting.

LEGAL.

The Cassel Gold Extracting Company, Limited.

By order of the Court of Appeal, a question on minutes was argued on Monday before Lords Justices Lindley and Smith.

Mr. Moulton, Q.C., who appeared for the Cassel Gold Extracting Company, Limited, said on April 8th their Lordships dismissed the company's appeal against the order of Mr. Justice Romer in favour of the Cyanide Gold Recovery Syndicate, Limited. Their Lordships, however, varied the decision of Mr. Justice Romer on all points except one—they found that the subject matter of the patent was good, that the invention was novel and useful, but held that it was bad because the first claim was too wide. There being a decision in favour of the Cassel Gold Company on all issues except one, he submitted that it would be hard on the plaintiff company to make them pay the whole of the costs. Neither in the Court below nor before their Lordships was it argued that it was unknown before the date of the patent that cyanide of potassium would extract gold from ore when in a finely divided condition; and it was quite unnecessary for the defendant company to put 24 specifications to prove prior anticipation, only three or four of which were after all dealt with. He submitted that the plaintiff company ought in fairness to be called on to pay the costs incurred by their own objections, on which they failed on appeal.

Sir Edward Clarke, Q.C., said the plaintiffs failed both in the Court below and on appeal to support their patent, and it would be hard to call on the defendant company to pay the costs of objections which they were bound to take at the trial. The plaintiffs' patent was held to be bad because their first claim was too wide, and therefore they ought to bear the consequences.

Lord Justice Lindley said the case presented some difficulties. Looked at from the plaintiffs' point of view, he was not surprised at their desire to cut down costs, as they succeeded on appeal on so many points. On the other hand there was a great deal of justice in the view presented for the defendants by Sir Edward Clarke. In dismissing the appeal, the Court affirmed the order of Mr. Justice Romer, and the successful party must have the costs of the appeal. The appeal must therefore be dismissed with costs; but with regard to this application, each party would pay their own costs.

Muirhead v. The National Electric Supply Company, Limited.

This action, which came before Mr. Justice Day without a jury, was taken by Mr. John Muirhead, a former director of the National Electric Supply Company, Limited, to recover £300, being the sum due for directors' fees incurred between 1891 and 1894. By the articles of association it was provided that the remuneration of the board of directors should be £200 per annum to the chairman and £100 per annum to each of the other directors. The memorandum of association provided that there should first be set aside out of the net profits of the company such percentage thereof as should from time to time be appropriated by the articles of association to payment of directors' remuneration. Mr. Muirhead was an ordinary director. No net profits had, in fact, been made by the defendant company.

Mr. McCall, Q.C., and Mr. Clauson, for the plaintiff, argued that the fees were payable, although no profits had been made.

Mr. J. Eldon Bankes, for the defendants, argued that upon the construction of the memorandum and articles in question, when read together, the agreement between the company and the directors was that the fees should be payable only out of profits.

Mr. Justice Day gave judgment for the defendant company, and said that upon the construction of the memorandum and articles of the defendant company the directors' fees were not payable except out of profits, and that, there being admittedly no profits, the plaintiff's claim failed. His Lordship granted a stay of execution for seven days, and directed that the £300, which had been paid into Court under the Master's order, should remain there pending an appeal.

Fowler v. The Chelsea Electric Supply Company—Sandon v. The Chelsea Electric Supply Company.

The first of these actions, which came before Mr. Justice North the other day, was by the tenant of a flat at the mansion, No. 75, Cadogan Gardens. The second was brought by the landlord and tenants of other flats in the house. In both actions it was sought to restrain the defendant company from continuing an alleged nuisance occasioned by noise and vibration. The actions were brought on on motions for interlocutary injunctions. It was arranged in each case that the motion should stand till trial, the writs being treated as statements of claim, the defendants to put in statements of defence within a fortnight, and leave being given to apply to have the trials expedited.

Mr Swinfen Eady, Q.C., with Mr. Rowden, and Mr. Samuel Hall, Q.C., with Mr. Badcock, were for the respective plaintiffs; Mr. C. A. Cripps, Q.C., Mr. Vernon Smith, Q.C., and Lord Robert Cecil for the defendants.

BUSINESS NOTICES, &c.

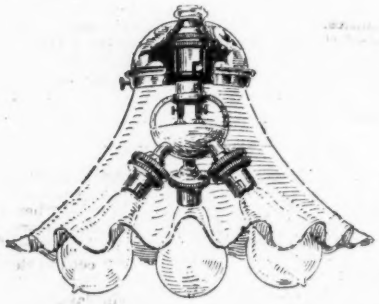
Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Association of Engineering Societies.—The journal of this association for April contains articles on "The Chicago Sanitary District Canal," "Railway Location and Construction," and "On the Best Arrangement of Longitudinal Bracing for Timber Trestles."

Bankruptcy Proceedings.—The summary and observations which were issued under the failure of G. B. Bruce Paton shows that his operations were mainly confined to the purchase and sale of bonds of American water, gas, and electric light companies, and he formed, among others, the California Gas, Water, and Electric Light Company Syndicate, Limited. He returns his unsecured debts at £3,315 19s., and his assets show a surplus of £2,327 17s. He attributes his failure to pressure by creditors and losses in connection with the syndicates, and other causes.

Change of Address.—Messrs. F. Ames & Co., makers of electric light fittings and accessories, have removed from Walterton Road, Paddington, to larger premises, at 1 and 2, Goldney Place, Goldney Road, Harrow Road, W.

Detachable Ball Fittings.—Messrs. B. Verity & Sons, of Birmingham, write to us as follows:—"We notice in your last week's issue a description of a detachable ball body suitable for use under a large shade. We should like to point out that there is no novelty in this arrangement, as we have been making our patent detachable body for 18 months for the purpose of overcoming the difficulty referred to,



viz., that under ordinary circumstances the shade over a cluster of lights cannot be removed for cleaning, &c. The arrangement, as worked out by us, possesses the additional advantage that a cluster of lamps may be replaced by a single lamp without the necessity of keeping a different ball body mounted with one socket only. We think the illustration will make this perfectly clear."

Ford, Lloyd & Co. — This firm finding its present premises at Camden Town inadequate, have taken works at Southampton in addition; the facilities for acquiring teak at the port and for working it on the spot economically being the chief inducement.

New Book.—Mr. Gisbert Kapp has arranged with Messrs. Whittaker & Co. for a translation from the German of his new work on the "Alternate Current Transformer;" it will be published in the Specialists' Series in the autumn.

Personal.—Mr. Walter C. Varcoe has severed his connection with Messrs Gwynne & Co., with whom he has been since the business of the Pilsen-Joel Company was taken over by them. Mr. Varcoe was previously with the "Pilsen" Company.

Price Lists.—The telephone price list of the Electrical Company, Limited, is now before us. It deals with long distance apparatus, the prefatory remarks bearing upon that subject. Various kinds of receivers, also small telephone sets, are referred to in the first few pages; there is a variety of micro-telephone instruments, magneto-apparatus, &c., &c. An illustration is included of nearly every article mentioned, and prices are also given in detail. The list is a very good one.

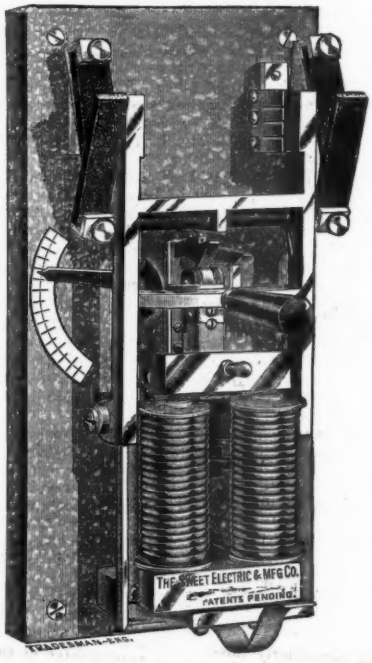
From the Acme & Immisch Electric Works, Limited, we have received advanced sheets of a catalogue of their switches (of various patterns and types), switchboards, fuseboards, fuses, and ampère-meters and voltmeters. The lists which are fastened in a manner that will allow of further sheets being bound in with them, are most beautifully printed in red and black and illustrated with nice blocks. Everything is most tastefully arranged, and the paper also is very good. We have pleasure in recommending the sheets to our readers notice, for we believe they will be found very handy.

Messrs. Beanland, Perkin & Co., of Leeds, have sent us a number of small lists of the Quanonne incandescent lamp, Pilsen arc lamp, cut-outs, dynamos, automatic alarums, electric air propellers, &c.

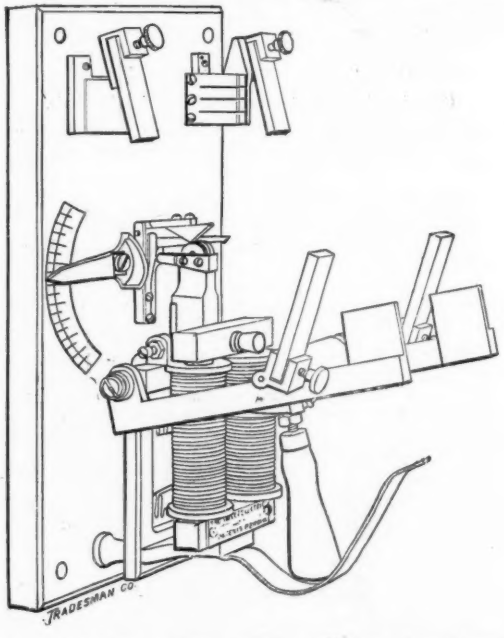
The D.P. Battery Company, Limited, has brought out its first price list, dated May, 1895, giving details, capacities, prices, &c., of the D.P. storage batteries.

The Smoke and Fumes Annihilator, Limited.—At meetings held at the Cannon Street Hotel, E.C., on May 8th and May 24th, 1895, a resolution was passed and confirmed winding up the company voluntarily. Mr. John Satchell Hopkins was appointed liquidator for the purposes of the winding up.

The Sweet Automatic Limit Switch.—It is a well-known fact among all practical electricians that a fuse is only a frail protection, available only as a last resort to protect the station when all the damage is done that possibly can occur outside the main point of distribution. This is inadequate protection to a power station. With the Sweet limit switch it is claimed that every dynamo, motor, lamp circuit, or whatever service it is in connection with, is entirely independent, for the reason that it is adjustable to $\frac{1}{100}$th of an ampère, and the current cannot exceed the amount to which the switch is adjusted without opening the circuit. The switch is said to be equally suitable in connection with all other electrical apparatus, as it is asserted to be a sure protection against an over-load or over-production of current. As a protection against fires, caused by short circuits due to wires coming in contact in buildings, it is said to automatically open the circuit, cutting off all currents from entering the building, on the immediate approach of any and all defects which produce an excess of current. This device, which is supplied by Messrs. J. B. Stone & Co., has two coils



from which the armature bar swings above on centres, and the locking and opening of the instrument is attached to a fibre suspension directly attached to the armature, with a steel roller which follows over a steel plate formed in such shape that when the armature begins to move, the force of the suspended arm is increasing rapidly, and the unlocking of the lever takes place with this force; as



soon as unlocked, the rotating carbons, with their outward pressure (which is given them by springs attached), makes the opening of the instrument positive in every detail. The breaking of the current is between carbons, in such a manner that when the metal contact is broken the contact is made on carbons, which are rotating, throwing in a resistance which, before breaking the final point of contact, greatly reduces the volume. The adjustment of the instrument is made by the lever attached to a cam adjusting the armatures to that of the field pieces, which is controlled inversely as the square of the distance of the armature in the instrument to that of the field pieces,

so that mechanically the pull or work the instrument has to do to open the circuit is practically constant whether in 1 ampère or in 500 ampères; any further than 1 ampère has less distance to pull the armature than for 500 ampères, and so positive and delicate is its adjustment that in the larger sizes—200 to 1,000 ampères capacity—the device will open on one-fourth of on ampère over and above its set capacity; and in the smaller sizes—one-half to 200 ampères—in less than $\frac{1}{10}$th of an ampère.

ELECTRIC LIGHTING NOTES.

Ayr.—The electric mains are to be extended round by Miller Road and Alloway Place at an estimated cost of £700.

Bedford.—The local authority has passed the plans prepared by the engineer for the extension of the electric light station. The engineer has been instructed to construct the sub-station at the corner of Alexandra Road, in accordance with the plan prepared by him; also to continue the low tension mains along De Parys Avenue and Burnaby Road forthwith. A sub-committee has been appointed to report upon the gas lamps to be discontinued in the public streets.

Cardiff.—At a recent interview with a press representative, the borough engineer (Mr. Harpur), stated that satisfactory progress was being made with electric lighting in the town. There were now 60 consumers, using between 4,000 and 5,000 lamps. Fresh applications were continually coming in. Extensions were contemplated in certain directions. The *Western Mail* says that about a quarter-past ten on Monday night, last week, every alternate lamp in the streets went out, and, as a consequence, the illuminating power in business and private houses improved considerably.

Chester.—We hear that the result of the six tenders which were submitted to Lord Kelvin for consideration is that the Electric Lighting Committee has decided to recommend the Council to accept that of Messrs. Parker, Limited, of Wolverhampton.

Coventry.—At the last City Council meeting it was stated that the whole of the plant would be sent from Leeds in about three weeks, and current would be supplied to citizens in about three months' time.

Dover.—A committee of the Town Council has been appointed to meet one of the directors of the electric light company, at the request of the latter, with regard to the lighting of the Town Hall by electricity. The hall has been fitted up at a cost of £600, and is also fitted for gas, so that whoever hires the building can use whichever light they desire. The committee will consider also what the charge shall be when electricity is used.

Edinburgh.—The Free Assembly Hall is now lighted by electricity. Current is taken from the Corporation mains, and the installation was carried out by Messrs. Smith & Co. The roof is studded with incandescent lamps of 50, 32, and 16 C.P.'s. Several rows of shaded lamps light the lower portion of the hall.

Hampstead.—The town clock at the Fire Brigade Station is to be wired for electric lighting at a cost of £17. Mr. Wm. Thompson is to carry out the work. Mr. Sayer, until now one of the assistants at the central station, has been appointed chief electrical engineer, at a salary of £200 per annum. The Vestry has also resolved that the necessary sub-station, feeder and distributors for the private lighting of Haverstock Hill, from Belsize Grove to Eton Road, be laid down at an estimated cost of £892, and that a high tension main for private lighting be laid down from sub-station 6A, in Heath Street, to the corner of Redington Road, at an estimated cost of £294.

Hanley.—Mr. Cottam, electrical engineer, tendered his resignation the other day, having obtained an appointment at Hampstead, and this the Council has accepted.

Islington.—The Electric Lighting Committee have found it necessary to purchase several small houses near the site of the electric lighting station now in course of erection, and the Vestry has consented to this course. The discussion reached the extreme height of bitterness towards the end, bullets of abuse were very rife. Some of the Islington vestrymen have strange ideas of dignity.

Ingleton.—A Mr. Bernstein wrote to the Parish Council the other day with reference to lighting the district by electricity. He was thanked for his information, but told that the time was not yet ripe for the introduction of electric light to Ingleton.

Leyton.—The District Council, the other day, again discussed the question of lighting the Town Hall, and ultimately decided that the wires for electrically lighting the Hall and Technical Institute be provided and laid.

London.—The electric lighting for the Royal Military Tournament at the Agricultural Hall, Islington, together with the ventilation of the Royal box, &c., the propulsion of the circular saws, and the apparatus for firing the detonators for exploding the mines, have been carried out by Messrs. Bergtheil & Young.

We understand that the private incandescent installation for the Tournament is being driven by three direct-coupled gas engine plants supplied by the Dawson Gas Engines Syndicate, Limited, two of the dynamos being of the Brush-Vienna type, and one of Crompton's. These sets are of a capacity of 2,000 watts each, and are running at a speed of 660 revolutions per minute.

London.—The Strand Board of Works the other day had before it a recommendation from a committee that the Bill proposed by the Charing Cross and Strand Electricity Supply Company for lighting the Strand district be opposed. The matter was referred back.

Newcastle.—According to a Newcastle paper, there is to be no buying up of existing electric light companies on the part of the Corporation. The Electric Light Committee have carefully considered Prof. Kennedy's recent report, and have come to the conclusion that they cannot recommend the Council to purchase existing rights. It is thought, however, that they have not abandoned the idea of a corporate electric light supply.

Oldham.—The Corporation Sanitary Offices in Mill Street are to be lighted by electricity. It is also thought that the police offices and cells should be likewise lighted electrically.

Rio de Janeiro.—The electric light is now used in the locomotive shops of the Central Railway at Rio.

Shanghai.—The report submitted by Mr. Charles Mayne, municipal engineer of Shanghai, in connection with the electrical department, for the year ended December 31st, 1894, states that during the past year the arc circuits have been extended 2¼ miles, while the incandescent circuits have been extended 3 miles during the same period. The erection of 12 additional lamps brings the total number of arc lamps for public lighting up to 100, the total number of arc lamps on the three circuits being at present 143. A new Marshall's 25 nominal horse-power engine and a 37½ kilowatt Mordey-Victoria alternator have also been fixed in the course of the year. For private purposes a total of 2,802 16-C.P. lamps are supplied, while 163 are in course of erection, a total of 2,965, as against 2,100 at the beginning of 1893. The council have been compelled to decline a good many applications for lighting, as when the installations now in progress are completed all the alternators will be running at their full capacity. As stated in a previous report, Mr. Mayne prepared complete plans for a new central electric lighting station. These buildings are now in course of erection. The plan of the buildings and the disposition of the plant is similar to the central station of the Manchester Corporation. As arranged at present there will be plant capable of running 236 arc lamps, including 55 held in reserve. Floor space is provided for plant capable of supplying another 100 lamps, making a total of 336. The incandescent plant will allow of 3,250 16-C.P. lamps being lighted at one time, including 650 lamps held in reserve. Accordingly, 5,000 16-C.P. lamps can be wired. Sufficient floor space is provided for running two additional alternators, which will allow of 5,000 more lamps being wired. To avoid unnecessary outlay on plant, and to provide against a large number of lamps breaking down at one time, it has been decided to adopt small unit machines (50 kilowatt), and to add to their number as occasion arises. The arc plant will be located on the north side of the engine room, and the incandescent on the south side, and the machinery will be laid down so that either set of plant can be extended according to the demand. There are now 9,091 16-C.P. incandescent lamps in Shanghai and its neighbourhood, all of which have been erected since March, 1890. Arc lighting in the streets was commenced in 1882. Mr. J. Price, M.I.E.E., superintends the work of the department.

Shanklin.—The lighting of the town dissatisfies the District Council, and the question of gas *v.* electricity has been referred to the Lighting Committee.

Ship Lighting.—The Cunard twin-screw steamer *Carinthia*, which has just been launched at Govan, is lighted throughout by electricity. There are two dynamos in the engine room, and at each of the seven hatches there is a cluster of 16 16-C.P. lamps. Messrs. W. Harvie & Co., Limited, are responsible for the lighting arrangements.

Southampton.—The action to which we have already referred taken by the Electric Light and Power Company against one of its customers came before the local Court again last week. It was adjourned until August 13th, with leave to apply.

Stafford.—A paragraph in the local press shows that the electric light works are progressing rapidly. The tender of Mr. Nevitt has been accepted for getting out the trenches and making good the pavements in connection with the laying of the mains for 1s. 6d. per running yard.

Sunderland.—The Electric Lighting Committee has decided to lay a main in Bedford Street. Residents of Thornhill Park and Crescent have asked for the extension of the light to that district. The question of the New Board of Trade regulations with regard to electric lighting came up for consideration. The electrical engineer was of opinion that these regulations would affect the Sunderland system; but as it was not his system, he did not care to give any definite opinion on the matter. It was ultimately decided to ask the opinion of Prof. Kennedy, whose scheme the Corporation adopted.

Warminster.—A reverend member of the District Council proposed the other day that the firm from whom the electric light plant was purchased (at a cost of £275) be asked to take it back again on certain conditions, one of these being that the firm had the order for the electric lighting plant when the Council really went in for it. The reason for the resolution being proposed was, that there is no immediate use for the plant. The motion was rejected by eight votes to five.

Yarmouth.—On the occasion of the visit of the Prince of Wales the band stand in Beach Gardens is to be decorated with 20 25-C.P. lamps at a cost of about £36, including cables.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

American Electric Railway Schemes.—A *Times* despatch from Philadelphia, dated May 27th, says that the Manhattan Elevated Railroad Company, which works the New York City Elevated Roads, is reported to have decided to change its motive power to electricity, and is selling an issue of Manhattan Consolidated bonds in London in order to provide funds. If London investors will not support electric railway schemes which are needed for their own metropolis, it will be somewhat surprising if they give assistance to trans-Atlantic schemes.

Coventry.—Messrs. J. & J. Cash, of Kingfields, near Coventry, are extending their premises to accommodate 40 large looms, each of which will be driven by an independent electromotor. The order has been placed for the necessary electrical machinery with the Coventry Electrical Engineering Company, Limited.

Derby-Ashbourn Proposed Railway.—We hear that a scheme for the construction of an electric railway between Derby and Ashbourn is being prepared. The towns are only 13 miles apart by road, but the present route by the North Staffordshire Railway is 30 miles.

Dublin Tramways.—In further reference to the feeling against the trolley system at Dublin, we now learn from the *Sunday World* that the Lord Mayor has returned from the Continent more favourably impressed than he dared expect with the tramways at Lubeck, Hamburg and Brussels. We are rather curious to see what course affairs will now take.

The Drumcondra Town Commissioners have resolved to send a petition in favour of the Dublin Tramways Bill now before Parliament.

Great Northern and City Railway.—The Unopposed Bill Committee of the House of Commons on Tuesday passed the Bill which gives an extension of time until 1900 within which to construct this authorised electric railway from the Canonbury branch of the Great Northern Railway, near Finsbury Park, to the City.

Isle of Man Tramways.—A party of Ashton engineers visited the Salford works of Messrs. Mather & Platt, Limited, on 18th inst., and there saw the stationary steam engines—five pairs of compound ones, of 150 H.P. each—which are being made for the purpose of supplying electrical energy for the mountain railway from Laxey to Snaefell, in the Isle of Man. Four boilers are to be supplied along with the engines for the same generating station.

Kingston Council and Electric Launch Charging.—The Council has adopted the following minute of the Lighting Committee:—"Reported that Messrs. New & Mayne had applied for permission to lay a pipe from their premises across Portsmouth Road to the river for the purpose of charging electric launches. It was decided not to accede to the application, as the Corporation were themselves making arrangements for charging launches. The electrical engineer reported that Messrs. Siemens had offered to supply and fit up the necessary cable, &c., for the purpose, from the electric works to the river, at about £100, and the Council was recommended to accept the offer and seal a contract for the work."

TELEGRAPH AND TELEPHONE NOTES.

Interruptions and Repairs to Cables and Landlines:—

		Interrupted.	Repaired.
Cable:	Brest-St. Pierre, Anglo-American Co.	6/4/93	...
„	Lattakia-Cyprus	27/11/94	...
„	St. Louis-Fernando de Noronha ...	12/3/95	25/4/95
„	St. Vincent-St. Thiago	4/4/95	25/4/95
„	Arcona-Trelleborg	20/4/95	21/4/95
„	Gibraltar-Tangier	24/4/95	15/5/95
„	Martinique-Paramaribo	8/5/95	...
Landline:	Siberian	22/4/95	23/4/95
„	„	25/4/95	28/4/95
„	Saigon-Bangkok	23/4/95	23/4/95
„	„ „	25/4/95	26/4/95
„	„ „	4/5/95	8/5/95
„	„ „	12/5/95	...
	Moulmein-Bangkok	29/4/95	2/5/95

The Powers and Submarine Cables.—A despatch from Paris, says that the *Debats*, in an article on the possibility of a war between France and Great Britain, calls attention to the great disadvantages France would be placed under by reason of the fact that England possesses nearly all the submarine telegraphic cables in existence. All the while this was so, and France did nothing to repair her neglect in this direction, England would be mistress of the sea, not because of the superior number of her ships, but because of the immense network of cables which belonged to her.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brighton.—June 1st. The time for sending in tenders for the supply of electric light lamps, pillars, and copper canopies for the Coporation of Brighton, has been extended until 10 a.m. to-morrow, Saturday.

France.—June 8th. Tenders are being invited for (1) the supply and erection of the necessary plant for the electric lighting of the Boucicaut Hospital, and (2) for the supply of the necessary electric lighting fittings. Tenders should be addressed to L'Assistance Publique, Avenue Victoria 3, Paris.

Godalming.—Proposals are invited for lighting (private and public) the borough for the Town Council.

Huddersfield.—June 1st. To-morrow is the last day for sending in tenders for the cables, transformers, switches, &c., for the Town Council's installation.

Italy.—The Italian Military Authorities at Pavia are at present inviting tenders for the supply of 105,600 metres of rubber-covered telegraph wire 1·6 mm. diameter. Tenders to be addressed to the Direz Offic di Costruz Mat. Genio Milit, Pavia, Italy.

London.—The Secretary of State for War has given notice that purchases of specific quantities of a variety of articles will probably be made from time to time during the current year. The list includes the following items:—Chain (iron, light and heavy), electrical instruments (submarine mining), India-rubber goods, lamps and lanterns, oils, spades and shovels, telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, Director of Army Contracts at the War Office, Pall Mall, S.W., by letter. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Manchester.—May 31st. This is the last day for sending in tenders for laying a system of underground telephone pipes, with brick inspection pits, service boxes, and other appurtenant works in certain streets.

Roumania.—June 5th. The Direction Generale des Postes et Telegraphes, in Bucharest, are inviting tenders for the supply of 4,000 Callaud cells.

Roumania.—July 29th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession for the construction and operation of an electric tramway along the main streets of the town.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Shoreditch.—May 31st. Tenders for wiring and fitting the Town Hall for electric lighting should be lodged to-day.

Wakefield.—The City Council on 17th inst. decided to advertise for tenders for carrying out the electric lighting works at a cost of over £20,000.

York.—June 10th. The North Eastern Railway Company invite tenders for the undermentioned articles in such quantities as they may require, during the six months ending December 31st, delivered, carriage paid, at the company's telegraph stores at York:—1. Telegraph apparatus. 2. Telegraph wires and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the secretary, Mr. C. N. Wilkinson, York.

CLOSED.

Cambridge.—The Town Council on the 23rd inst. adopted the system of fire brigade calls and street posts prepared by Mr. A. Barrett and accepted the tenders of Messrs. Baily, Grundy and Barrett, Limited, for carrying out the work.

Hanley.—The Council has accepted the tender amounting to £755, of Messrs. W. H. Allen, Sons & Co., for the supply of a condenser required at the electricity works; also that of Messrs. H. and T. Danks, £1,060, for boilers, electric light mains and other appurtenances.

CORRESPONDENCE.

Electric Lighting of Small Towns and Villages.

I think that under some circumstances the collection of a number of small central stations under one management might be conducive to the economical production of electrical energy, if the district to be served under one management be more than 5 miles from the central source of supply.

Within that radius, however, I think a far better plan than that which you suggest would be the adoption of the alternating high tension system.

As is well known, Mr. Ferranti has successfully transmitted electrical energy seven miles for lighting purposes. I do not propose that as high an E.M.F. as 10,000 volts should be used; but surely, with our present knowledge, there should be no difficulty in employing 5,000 volts? The supply and management would then be as nearly as possible under one *roof*, which should still more decrease the cost of supply, than would a number of isolated installations.

Under favourable circumstances, the capital expenditure per lamp, rent, wages, &c., would be considerably reduced, besides the higher efficiency gained by using larger units of plant.

You say that "should any interruption in supply occur, some six or eight places would be plunged into total darkness." I do not think that this is a sufficient reason for using a number of separate stations. If the central station be well equipped, and with sufficient reserve plant, it would be a serious accident which would entirely suspend supply for any length of time, and I think that the small continuous supply station, with the man and boy in charge, would be quite as liable to a breakdown.

Again, you say that "the small high tension mains connecting one town with another might be liable to damage from a hundred and one causes." I really fail to see why, if they be properly laid. There are in use to-day high tension mains which have been at work for years without the least trouble or fault.

You next say that "two or three experienced men would be required to attend to the sub-station in each locality." What would they be necessary for? Of course, the sub-stations would require periodically inspecting, &c., but I do not see that it would be necessary to keep a man, or men, in constant attendance, as you imply, as all the regulation would be done at the central station.

Lastly, as you justly observe, series incandescent lighting is advantageous, but devoid of novelty. Transformers can now be procured which will give a constant current. The streets could, therefore, be lighted by that method, without using the complicated, wasteful, and clumsy method of switching in an equivalent resistance, should a lamp fail.

Wm. J. Sowter.

Re Conduit Wiring.

With reference to the article in your last issue, on conduit wiring, and thinking that some particulars of a system which has been extensively used in this country for some considerable time, may be of interest to you, I am forwarding you description of the London and Lancashire system of conduit wiring which has been in use with perfect success by my company for about two years.

C. N. Russell,

Manager, London and Lancashire Electric and General Engineering Company, Limited.

NOTES.

The E.M.F. of Alloys.—The December issue of the *Journal* of the Chemical Society contained the paper by Mr. A. P. Laurie on the electromotive force of alloys in a voltaic cell, which, as we informed our readers about a year ago, he had undertaken to prepare. It was suggested to him by a study of Matthiessen's well-known paper in an early number of the *Philosophical Transactions*, 150. The results of determinations of the electromotive force of 16 of the 19 alloys referred to by Matthiessen are here given, and it is interesting to observe that the latter's conclusions are entirely confirmed, namely, that only one compound exists amongst the 16—the tin-gold alloy. The others were bismuth-tin, bismuth-lead, bismuth-gold, bismuth-silver, gold-silver, antimony-lead, cadmium-zinc, antimony-tin, lead-gold, lead-silver, lead-tin, lead-zinc, lead-cadmium, and cadmium-tin. The method employed in examining these alloys was to prepare small samples from approximately pure metals, and by means of a Thomson quadrant electrometer, to test the E.M.F. in voltaic cells of various construction against that of a standard Daniell.

The Behaviour of a Vapour in an Electric Field.—The saturation pressure of a vapour in an electric field forms the subject of a neat mathematical analysis in the *Journal de Phys.*, iv. (1895), pp. 53—62, by A. Sokolow. The conditions examined comprised a charged condenser consisting of two large metal plates separated by thin layers of an insulating liquid and its vapour. The state of such a condenser is assumed to be perfectly determined by the temperature, t, the volume of the dielectric, v, and its electric charges $\pm$ E, p being a function of t and E. On these assumptions some interesting equations are based. The paper, however, is not susceptible of useful condensation, and our readers must be referred to the original.

The City of London College Science Society.—On Saturday, 8th prox., a party from this College will visit the Deptford Station of the London Electric Supply Corporation, Limited.

To English Wire Makers.—We would draw the attention of English wire makers to the remarks made by the President of the National Telephone Company at the Telephone Inquiry. Towards the end of the third column of our report of the proceedings, Mr. Forbes is made to say that "although he regretted it from a sentimental and patriotic point of view, they were obliged to go to Germany to get the best wire." What have our home manufacturers to say to this?

Junior Engineering Society. — On Tuesday next, June 4th, at 6 p.m., the members of this society will visit the works of the Waterloo and City Railway. Entrance at Upper Ground Street, Blackfriars.

Platinum Resistance Pyrometry.—Four methods have been resorted to usually in determining high temperatures, namely: (*a*) Air thermometers, (*b*) calorimetry, (*c*) the change in the E.M.F. of a thermo-couple, (*d*) the change in the resistance of a platinum wire. Of these, it now seems that the last-named is to be preferred when it is desired to indicate temperature rapidly, and at the same time measure small differences with accuracy. If these conditions are postulated, the first two methods are instantly placed out of court, whilst the third is wanting in delicacy. The method of platinum resistance pyrometry, first suggested by Siemens, has been brought to great perfection by Callendar and Griffiths (*vide Phil. Trans.*, A., 1887, p. 161; A., 1891, p. 191). It seems, however, not to be as sufficiently well known and practised as it deserves. We are glad to see, therefore, the method adopted by C. T. Heycock and F. H. Neville, in an important paper recently published by them on the determination of high temperatures. Their results are so striking, that we think they cannot fail to attract renewed attention to this excellent system of pyrometry.

Mine Accident.—While a workman was in charge of an electric drilling machine at Lumpsey Mine, Brotton, his clothing was caught in the screw, and he was in consequence severely injured.

A "Multivolt" Battery.—An "interesting" type of primary battery is (says the American *Electrical Review*) made by the Multivolt Battery Company, of Brooklyn. In brief, this battery consists of a number of independent cells, the containing vessels of which have holes in them, and which are all immersed in a single vessel containing an exciting fluid; in other words, there are a series of leaky cells, each on partial short-circuit, and the electromotive force of the combination is that of the cells in series diminished by the partial short-circuiting. The result of this wonderful and "interesting" arrangement is, that a 6-cell battery, which should have given normally 12 volts, actually gave only 5, at which the *Electrical Review* expresses astonishment. Truly, our American friends have something yet to learn in elementary electricity.

The Hope-Jones Electric Organ.—Mr. Robert Hope-Jones, who has just erected a large electric organ in St. George's Church, Hanover Square, gave an invitation on Wednesday to a number of musical gentlemen and Press representatives to examine the organ and have its construction explained. Mr. Hope-Jones's lucid description of the many peculiarities and advantages of the new system he is introducing, enabled his audience to appreciate the great improvements thereby effected in the building of organs. The greater part of the organ at St. George's is placed on the western gallery, but the "swell" stands in the tower outside the building. A set of swell shutters controls the opening between the tower and the church. Electric motors for blowing are placed in the tower above the swell organ. These motors are controlled by switches fixed on the movable console or key desk, which is placed in the chancel, nearly 100 feet from the organ itself. The console is fitted with an arrangement of compound composition keys, by means of which the organist can obtain any combination of stops and couplers, together with a suitable pedal accompaniment, without raising his fingers from the keys. Three of the manuals are fitted with a "double touch," which enables the organist to obtain *expression* from the fingers somewhat as in the pianoforte. The stops are actuated by a row of small ivory levers, called "stop keys," placed above the upper manual; these are pivoted in the centre, and require but a light touch of the finger to throw them on or off. In the centre of the row of stop keys is placed a small ebony key called "stop-switch," which enables the organist to prepare his combinations beforehand, or while playing. The connection between the keyboard and the pipes consists of a cable about 1½ inch in diameter, consisting of about 1,800 small wires. Each pipe is closed by the usual pallet, which, through the medium of a pneumatic valve action, is actuated by a tiny metal disc. On touching a key an electromagnet attracts this disc, moving it about a hundredth part of an inch, and this minute effect is sufficient to cause the pneumatic action to work and the pipe to speak. The amount of current required is quite trifling, two or three dry cells being sufficient for a large organ.

The Explosion at Fairfield Works.—It is a pity, in a sense, that so much fuss has been made of the fact that a nipple was blown out of a Babcock boiler at Fairfield Works on April 1st. The blowing out of this nipple has nothing whatever to do with the safety or otherwise of the boiler. The nipple was a temporary expedient for closing the hole left by the removal of a water tube for temporary purposes, and probably the closing nipple or thimble was not thoroughly expanded in its hole. We need not dilate on the want of safety of the water tube boiler. Advocates of shell boilers will tell us that there is no evidence to prove that the shell boiler is not fully as safe or safer than any water tube boiler yet invented. This Fairfield explosion has nothing to do with the matter, but as the Sheriff pointed out, in place of nipples a through piece of tube should have gone through the header, taking the place of the removed tube end and of the cleaning cap. A nipple such as we gather was used, is not a suitable fitting for the purpose, though possibly it might have been expanded differently, and more in the manner of ordinary flue tubes, on each side of the plate it stopped, as well as in the plate itself. It would not then have blown out as it did before leaking badly. Probably, being a temporary fitting only, the proper expanding was omitted, for this would have rendered the nipple difficult to remove.

A Tall Tale.—We have heard a story of wonderful dimensions, which is published in London as an account of a phenomenal occurrence at New York on Monday last. Inspired with tragic terror, the writer of a certain news agency says :—

> At noon to-day it suddenly became very dark here. The darkness, which equalled that of the darkest night, lasted half an hour. The gas and electric lights in the public and business buildings were lit. Suddenly a ball of fire, a foot in diameter, appeared in the sky, and fell in the middle of Anne Street, not far from the *World* and *Herald* offices. As it fell it broke into a thousand pieces. Such an occurrence has never startled the residents of New York before.

We expect to hear later, if we hear anything more about it, that there was a flash of lightning, and vivid imagination did the rest. But then, the story is American.

A Grievance.—A correspondent who carries on the business of an electric light engineer and contractor, not a thousand miles from the West End of London, brings under our notice "a mild instance of what is being done in this heaven-born trade." Along with others, our correspondent was recently asked to tender for a small wiring contract, and has reason to believe that his ideas, as suggested, were approved of; but just as the order should have been secured, in step the —— Electric Supply Company, and say they will do the work. "This is, of course, all right in its way, and I suppose it pays them; but I should have thought it paid them still better, or, at least, their shareholders, to leave contractors alone, and confine their attention to their supply stations." Personally, our correspondent says he does not care "two straws" for the —— (or any other supply company for that matter), "as they ought to know to their cost, when the Lyceum was put on the Charing Cross and Strand supply, and the Oxford was put on the St. Pancras supply—the two together representing a gross income of about £3,500 a year to the shareholders."

Potential Gradient in a Positive Glow Discharge.—By means of 1,040 Planté cells it is possible to produce in a vacuum an unstriated positive glow discharge. This has been recently the subject of an investigation by A. Herz. He measured the potential difference between two points in the discharge by means of a standardised quadrant electrometer, and then calculated the potential gradient. He found that in hydrogen gas, with a current of 1 milliampère, the potential gradient in volts per cm. = 64·5. With a current of 1·2 milliampères in nitrogen, other things being equal, the potential gradient = 92·2. The results, which may be seen in detail in *Wiedemann's Annalen*, liv. (1895), pp. 244—264, are embodied in 15 tables, but may be summarised as follows :—The potential gradient in a positive unstriated glow discharge, with constant current, decreases with increase of current, and the equation :

$$v = v_o - b\,(i - i_o),$$

when v = potential gradient, i the increase of the current, and b the decrease of the potential gradient per unit increase of current, gives with sufficient accuracy the magnitude of this decrease. The value of b decreases with increasing width of the luminous discharge in the tube, and is almost independent of the pressure, and has about the same value for nitrogen as for hydrogen. The potential gradient also decreases with increasing pressure, but more slowly than the pressure increases. At pressures between 4 and 8 mm. of mercury, the potential gradient for nitrogen free from oxygen is 1·4 times that for hydrogen.

Secondary Batteries in Central Stations.—The paper on the "Uses of Accumulators," which we conclude in this issue, is of the utmost significance, and Mr. J. C. Howell is to be congratulated upon the very masterly and convincing manner in which he has given his data. Many articles have appeared in the Review on the subject of economy in central stations, but it has been reserved for Mr. Howell to place the present situation in its true light, and to suggest what, to us, seem eminently practical remedies for reducing not only the coal bill, but labour as well. The chief point with regard to the extensive employment of secondary batteries seems to be that of depreciation, and there are not a few engineers who will contend that 10 per cent. per annum is not enough to allow for this contingency. However, everybody will agree that without storage no central station can be on level terms with gas supply, so we trust that the very plausible, and apparently truthful, picture Mr. Howell has drawn will not be without its effect upon those who stand by the continuous current system. To utilise the plant of an electric light central station to the full has ever been the chief desire of the engineer-in-charge; Mr. Howell shows how it can be done at the present day to the best advantage.

Fire.—A small fire occurred behind the scenes at a Paris theatre last Friday night, for which the electric light was said to be responsible.

The annexe of the Exhibition at Prague containing the electric lighting machinery was burnt down early on the morning of the 24th inst.

Experimental Proof of the Laws of Van't Hoff, Arrhenius and Ostwald, for Dilute Solutions.—Although the work of M. Wildermann on the subject of dissociation in solutions is not, perhaps, so well known as that of his contemporaries, he has made some valuable contributions to our knowledge of a branch of physical chemistry concerning which there has been much controversy. He it was who, in 1893 (*vide Berichte der Deutschen Chemischen Gesellschaft*, xxvi., p. 1,773), recognised the existence of two sorts of dissociation, namely, electrolytic dissociation into ions, and a non-electrolytic dissociation of larger molecular aggregates of the dissolved substance into smaller aggregates. In his opinion, the assumption of non-electrolytic dissociation is sufficient to account for, if not to explain, the divergencies existing between the observed data and the values calculated on the electrolytic dissociation hypothesis alone. Wildermann has recently published a paper in the *Zeitschrift für Physikalische Chemie*, 1894, xv., p. 337, in which he discusses the experimental proof of the well-known laws of Van't Hoff, Arrhenius, and Ostwald, for dilute solutions. The freezing points of very dilute solutions have been determined with great care, every precaution having been taken in order to secure the highest attainable degree of accuracy. Experiments with the non-electrolytes, cane sugar, carbamide and alcohol, show that these, when existing in exceedingly dilute solutions, give results which are in perfect harmony with Van't Hoff's formula for the molecular reduction $0{\cdot}02\ T^2/w$, if for w the value 80 cal. is taken. The electrolytes sulphuric acid, potassium chloride, di- and tri-chloracetic acid, and ortho-nitrobenzoic acid, all give reductions of the freezing point of water which are in accord with the view that these substances have undergone electrolytic dissociation to the degree indicated by the electrical conductivity measurements of the corresponding solutions. The dissociation calculated from the freezing points is, however, somewhat smaller than that calculated from the conductivities; and this Wildermann considers may be accounted for by the presence of higher non-dissociated and dissociated molecules in the solution: in other words, by admitting the theory proposed by him in 1893, to which allusion is made in our opening paragraph. The accuracy attained by Wildermann in his more recent experiments is sufficient to enable calculations to be made of the affinity coefficients from Ostwald's law of dilution, in the cases, at least, of di-chloracetic and ortho-nitrobenzoic acids. The calculated value is practically independent of the dilution in each case, but is somewhat smaller than that obtained from the conductivity.

Lighthouse Illumination.—In connection with our "leader" this week, it is interesting to note that a new lighthouse which is expected to be completed by the end of next year at Penmarch Point, on the coast of Brittany, is to be furnished with the electric light, of such intensity as to be visible at a distance of nearly 100 in clear, and from 25 to 28 miles in hazy weather. The actual illuminating power of the light will be 10,000,000 C.P., which is much greater than that of La Hève (Seine Inferieure), admittedly the most powerful light at present on the French coasts. It may be remembered that the late Marquise de Blocqueville, daughter of Marshal Davoust, Prince of Eckmühl, in whose memory the lighthouse is being erected and named, left a sum of 300,000 francs to defray the cost of this important work, and that the French Government added a similar amount in order that the lighthouse might be equipped in the most up-to-date fashion.

The Institution of Civil Engineers.—The annual general meeting was held on Tuesday, the 28th inst. The ballot for council resulted in the election of Sir B. Baker, K.C.M.G., as president; of J. Wolfe Barry, C.B., W. H. Preece, C.B., Sir Douglas Fox and James Mansergh, as vice-presidents; and of W. Anderson, D.C.L., Alex. R. Binnie, W. R. Galbraith, J. H. Greathead, J. C. Hawkshaw, C. Hawksley, Dr. John Hopkinson, Alex. B. W. Kennedy, LL.D., Sir G. L. Molesworth, K.C.I.E., Sir Andrew Noble, K.C.B., Sir E. J. Reed, K.C.B., M.P., W. Shelford, F. W. Webb, Sir W. H. White, K.C.B., and Sir E. Leader Williams, as council members. The session was adjourned to the second Tuesday in November.

Death from Low Voltage Shocks.—In our last issue we gave the opinions of several writers regarding a fatal accident which recently occurred in an American mine through shock. Another letter on this subject has since appeared in the New York *Electrical Engineer* from the pen of Mr. Arthur J. Farnsworth, in which he says that it has been frequently pointed out that it is *current*, and not *voltage*, that kills, and that the human body is not at all like a voltmeter, or other device of constant resistance, which can always be placed across the terminals of the circuit for which it is intended.

If we should attempt to name a voltage that is capable of being handled at all times, by all persons, and under all circumstances with impunity, we would be compelled to make it very low indeed. The writer would not dare place it above 50 volts, and deaths have actually occurred from contact with 50-volt circuits, although probably from leakage currents. On the other hand many persons have received shocks from contact with circuits of several thousand volts without injury, and D'Arsonval cites the case of a man subjected to an E.M.F. of 2,000 volts for several minutes without any disagreeable results to speak of, beyond temporary unconsciousness. Of course, the reason for this great discrepancy is that the resistance of the body changes enormously under different conditions of contact. It is also exceedingly likely that different conditions of health in an individual render him at one time more likely to succumb to electric shock than at others. The writer is also convinced that deaths of persons shocked by electricity have been the result of fright and superstition. Recently a coachman was shocked from a 104-volt circuit, and, although he was entirely uninjured, it took several hours, and many persons, to convince him that he would not die. Pale and trembling, he expected each moment to be attacked by convulsions and other symptoms of the *poison* with which he apparently considered himself inoculated. In the case mentioned by Mr. W. J. E. Carr, I would be inclined to believe that the man died from the cause just mentioned, for Mr. Carr distinctly states that the autopsy showed no signs of bursted blood vessels or other symptoms that usually result from such experience. Had the examination showed otherwise, I would think that the man was either in wet boots, or attempted to open the circuit through his body, and thereby subjected himself to the E.M.F. of self-induction of the circuit, which might be much higher than the working voltage.

Telegraphy by Induction.—In his lecture on this subject, which we mentioned last week, Mr. W. H. Preece, after remarking that he had adopted this title to distinguish the subject of his address from telegraphy by conduction, said that telegraphy by induction meant signalling through space by electro-magnetic waves, the points between which communication was desired not being joined by any conductor. A somewhat analogous process was the use of the heliostat in India, by which signals flashed by the rays of the sun conveyed information from Chitral to the relieving army. In this latter case the instrument which received and translated the signals was the eye, but in the experiments which he was now discussing the receiving instrument was the telephone. In 1884 an operator in the telephone company's exchange room near that spot read some messages that were being sent to Bradford from the General Post Office through a wire in the department's iron pipe, buried underground in Gray's Inn Road, although the telephone wire ran along the house tops 80 feet away. An exhaustive series of tests and experiments proved beyond all doubt that this was a case of pure induction. In 1885 induction experiments in the neighbourhood of Newcastle traced the effects to a distance of 2,000 feet. Distinct speech was carried across a space of a quarter of a mile. Other experiments followed, but the final practical success which was now assured was obtained last March in connection with the repair of the cable connecting the island of Mull with the mainland, near Oban. It was difficult to forecast the future of this new telegraphy. They had signalled in one direction only, but he saw no reason why they should not duplicate and quadruplicate their messages. Each particular circuit had its own sympathethic frequency, and each telephone responded to one particular note better than to any other. They were seeking some convenient place within reach to establish the system permanently. Leisure in his case was wanting, but it was replaced by willing, energetic, and unselfish assistants.

The Chemnitz Station.—We regret to find that through an oversight, our recent article describing this station contained no reference to the source in which the original description appeared. Our article was a translation of a pamphlet which was a reprint from the *Elektrotechnischen Zeitschrift* for January 3rd, 1895.

Accessories and Fittings Trade.—That a good time is coming for the electrical trades in the near future seems to be the firm conviction of the majority of our manufacturers. In no way is this better evidenced than in the constant endeavours made by them to arrange their works so as to be ready for the fully expected increase in the output. We recently had an opportunity of going over the works of Messrs. B. Verity & Sons, at Aston, Birmingham, where everything has been done to turn out their electric light accessories, not only in a first-class manner, but to enable the firm to keep pace with the orders as they increase from time to time. The firm pride themselves on making in their factories every part of their fittings, including all the small details of lamp sockets, tumbler switches and fuses, and making, by means of specially devised machinery, all the parts of each kind of apparatus practically interchangeable with every other apparatus of the same kind and size, a very satisfactory result being obtained. Some idea of the trade in lamp sockets alone may be given when we mention that this one firm in this, the slackest, season, is turning out about 3,000 per week. Each socket goes through about 25 distinct processes before it arrives at its finished burnished state, ready for delivery to the trade. In the case of key lampholders, of which the firm make rather a specialty, the number of processes is, of course, considerably greater as the article is more complicated. The manufacture of the tumbler switches by this firm is equally interesting to watch, and is very extensive. We were informed that each switch passes through about 63 pairs of hands before being finished ready for sale. Large numbers of richly chased and highly ornamental switches, suitable for the drawing-room and the boudoir are turned out, conclusive evidence if such were needed, that electricity is being rapidly adopted in the best class of residence. Having inspected the various processes employed in the smaller accessories and fittings, we visited the case works, the brass foundry, and the pottery and slate stores. Passing thence through the drawing offices and the mounting rooms to the finished goods in warehouse, we arrived at the metal stores and polishing departments, and so to the large work rooms, where the larger fittings and electroliers are made. Here were to be found some very beautiful things made of brass, iron, and copper, and, in some cases, of two of the metals combined, hammered and cast work being judiciously arranged to produce the required effect. Although prices are cut very fine now, yet, with system and proper mechanical aid, it is evident from what we found there, the workers can earn quite as much money as they could when switches were three times their present price. The best of feeling prevails between employer and employed, and nothing in the nature of "strikes" ever appears to ruffle the harmony existing. After spending a most pleasant and instructive time with the heads of the staff in this busy atmosphere, we came away strongly impressed with the foresight, energy, and aptitude for seizing the golden opportunity, so strongly characteristic of the two brothers who control their very successful factories in Birmingham and London.

An Application of Electricity to the Bleaching of Oils and Fats.—It has recently been claimed that oils and fats may not only be bleached, but sweetened and purified generally by treating them with an electric current. The system upon which this is effected is as follows :—There is a tank divided into two parts by means of a porous partition ; in one of the compartments thus formed is placed a solution of common salt at 8° Twaddell strength, and immersed in this solution is a carbon electrode. In the other compartment there is a mixture of the oil or fat with a similar salt solution, and immersed in the mixture is a copper electrode. A continuous electric current is then generated by means of a dynamo, the oil and salt solution being agitated by mechanical means at the same time.

The Royal Society.—Before this Society, yesterday afternoon, the following papers were read :—"On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light. Preliminary Notes of Observations made at Daramona," by W. E. Wilson. "On the Velocity of the Ions," by W. C. Dampier Whetham.

The Action of Synchronous Motors.—Those who like to see matters of fairly common knowledge lucidly explained, should not fail to read a joint paper by F. Bedell and H. J. Ryan in the *Journal* of the Franklin Institute, No. 831, March, 1895, pp. 197—214. If they have any difficulty in clearly understanding the action of synchronous motors, this paper will succeed in putting them right. Although there is nothing new perhaps in the paper, it is well worth reading, for the authors have done their somewhat difficult task extremely well. It is a paper to be read, studied and filed. It contains clever diagrams of the phase relationship between the current and the E.M.Fs. of the generator and the motor, which have been obtained by direct experiment; and these are compared with advantage with such as can be educed from a consideration of general theoretical principles and *ab initio* reasoning. Perhaps the most interesting part of the paper is the description of the Bedell motor, phase indicator, and synchroniser. The diagrams with which this paper is profusely illustrated, clearly emphasise the necessity for considering armature reaction when determining the working conditions of an alternating current plant.

Electric Railway Conduit Systems.—An electric railway conduit system has recently been patented in England by Mr. J. E. Parker, of New York, who has apparently devoted considerable time to a solution of those difficulties which have heretofore been found most annoying where it has been proposed to furnish current for electric tramways by means of sub-surface conductors. Under the construction proposed a trolley wheel, similar to that which is used on overhead conductors, is carried within the conduit, running upon a strip conductor held edge-ways upon insulators set centrally under the slot of the conduit. The metal of which the conduit itself is formed is utilised for the return circuit, contact therewith being maintained by means of an "expandable" wheel which runs in the groove of the slot. The carrier from which this latter device is supported is also furnished with ploughs at either end, the purpose of which is to keep this slot always clean. Several other devices are shown in the patent, whereby it is considered the work of construction and of cleansing will be greatly facilitated. It is, of course, difficult to judge of the possibilities of the invention from patent drawings, but it would seem to us that Mr. Parker's construction would require to be greatly increased in weight of material and internal dimension before it would receive acceptance from English tramway engineers. It is also questionable whether it is not a serious disadvantage to have the insulators and conductor directly under the slot, where they are not only exposed to the constant drippings, but also are directly in the way of any appliance used for sweeping and cleansing the conduit drains. Up to the present time, all attempts to work electric tramways by means of conductors carried in comparatively shallow conduits have proved conspicuous failures, solely on account of the great difficulty met with in securing effective drainage and efficient insulation, and the climate of England is especially unsuited to any system of underground construction which does not afford very ample opportunity for the most perfect insulation and cleansing.

Low Pressure Currents in Metallurgy.—More than a year ago we called attention to some interesting laboratory experiments made by J. Garnier, and described by him in a paper contributed to the *Proceedings* of the Paris Academy of Science, in which he showed that an electric current of low pressure can be employed in the "cementation" process for heating iron. The results were suggestive, and at the time we ventured to express the hope that Garnier would explore this particular field of research more completely. He appears to have done so, and amongst other results, he has thrown light upon the electro-chemistry of fused sulphide ores. It appears that when the sulphides of the metals are treated with low pressure electric currents, the sulphur is eliminated. The percentage of sulphur seems to diminish from the anode to the cathode, whilst the percentage of metal increases in the same direction. Really it would appear that, given that this application of electricity can be made with sufficient economy, we are on the eve of some revolutionary discoveries in connection with the winning of the metals from their natural ores.

Empire of India Exhibition.—Apart from its special Oriental characteristics, the Empire of India Exhibition will be full of interest to electrical men. The old plant which formerly did duty for the previous Earl's Court exhibitions had been entirely superseded, and a large central station has sprung up in its place. In this are several Brush arc lighters and a Mordey alternator. We shall, however, have more to say on this subject later on, when we hope to give some interesting details of how the lighting is done in India.

CITY NOTES.

The Bournemouth and District Electric Supply Company.

The accounts for the year show a profit on the year's working of £1,642. After paying interest on debentures, interest and commission on loans for capital purposes and other items specified in the appropriation account, a balance of £395 is left, which is applied to the reduction of the suspense account.

We are glad to see that there has been a satisfactory increase in the number of lamps connected, but the cost of production is exceedingly heavy, coal alone costing 2d. per unit, with salaries and repairs absorbing another 2d. per unit, it is not surprising to find the works' cost amounting to 4·60d., and the total cost to 5·8d. per unit. The company has had many difficulties to contend with, but we trust that the recent additions and extensions will materially help towards a more prosperous career.

The cost of production is as follows:—

	1892.	1893.	1894.
Total capital expended ...	—	£40,536	£50,708
Number of units sold	—	—	214,374
Number of lamps connected ...	—	14,500	19,000
Revenue from sale of current...	—	—	£6,643
Net revenue	—	—	£1,642
Average price obtained per unit	—	—	7·4d.

Cost of Production.	£	s.	d.	Per unit.
Coal	1,785	0	0	2·00d.
Oil, waste, water, and engine room stores	388	0	0	·43d.
Salaries and wages at generating station	1,032	0	0	1·16d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	905	0	0	(Works' cost 4·60d.) 1·01d.
Rates and taxes	313	0	0	·35d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	780	0	0	·87d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£5,203	0	0	5·82d.

Revenue.				Average price obtained per unit.
By sale of current	£6,643	3	11	7·4d.
Meter rents	318	2	2	—
Sale of lamps	—			—
Total	£6,961	6	1	7·4d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·82d.; works' cost, 4·60d.

The Consolidated Telephone Construction and Maintenance Company, Limited.

The report to be presented at the fourteenth annual general meeting of the company, to be held at Winchester House, Old Broad Street, London, on Thursday, June 6th, 1895, at 12 o'clock, noon, states that the operations for the past year show a manufacturing profit of £1,403 9s. 1d. The amount available for disposal (after the usual provision for doubtful debts, and after writing off £63 16s. 8d. from the new building account, £12 19s. 4d. from furniture account, and reserving £57 8s. 10d. for rentals paid in advance), is £2,866 10s., from which the directors propose to pay a dividend of £1 10s. per cent., leaving a balance of £1,236 6s. 10d. to carry forward. The competition (principally foreign) in the manufacturing business has continued with unabated severity, the selling price of all articles having been largely reduced. The lease of the present factory terminates at Christmas next, and it is proposed, if suitable premises can be found, to remove the plant, machinery, &c., to the country, with the object of reducing the expenses of production, in the shape of labour, rent, and the heavy rates now being paid. Various manufacturing proposals have been submitted to the directors, one of which, for the manufacture of an unique form of battery and accessories, has been adopted, the company having obtained the sole right to manufacture all supplies required by the patentees of the "Capsule battery" for the whole period of the patent, viz, 14 years. It is proposed to alter the "memorandum of association," to enable the company to manufacture other articles than those solely electrical, and a resolution will be submitted to that effect at the extraordinary general meeting. The directors are hopeful that this extension of business will be advantageous to your compmny. A resolution to alter Article 83, as to the number of directors, will also be submitted. The la suit in Belgium, undertaken in conjunction with the Edison Gower-Bell Telephone Company, against infringers of the patent held by the company, resulted in a successful appeal against the previous decision, and the Court has ordered a claim to be sent in for damages. The last report of the Edison Gower-Bell Company, dated February 28th, 1895, has the following paragraph regarding the litigation:—"The directors are pleased to report, in connection with the company's patent rights in Belgium, that the action in the Court of Appeal at Liege, referred to in the last two reports, has resulted in a reversal of the previous verdict against the company, and in the Zurich Telephone Company, working at Namur, being found in damages and costs. The question of the amount of damages to be assessed is now being argued before the Court." The directors have resolved to defer the payment of their fees. The subsidiary company, the Anglo-Portuguese Telephone Company, continues to show satisfactory progress, as will be seen by the following comparative statement:—

YEAR ENDING MARCH 31ST.

Subscribers.		Rental.		Increase.	
1894.	1895.	1894.	1895.	Subscribers.	Rental.
2,320	2,439	£15,076	£16,040	119	£964

In accordance with the articles of association, Mr. C. L. W. Fitz-Gerald retires by rotation, and being eligible, offers himself for re-election; Mr. J. H. Buckingham also retires by rotation, but does not offer himself for re-election. The auditor, Mr. J. G. Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), also retires, and offers himself for re-election.

Reuter's Telegram Company, Limited.

ADMIRAL THE RIGHT HON. SIR J. C. DALRYMPLE HAY, BART., presided at the ordinary meeting of this company, held on Wednesday. In moving the adoption of the report, he congratulated the shareholders on the great improvement it showed over its predecessor—a profit of £4,485, as compared with a debit balance of £2,766 in 1893. It would have afforded the directors great pleasure to declare a dividend, but the necessity of dealing with the loss on the operations of 1893 rendered that impossible. When he addressed them last year he mentioned that the fall in silver had prejudicially affected their business, and that they had readjusted their arrangements in the East in consequence. The measures then taken were attended with the best results. Unfortunately, the economies effected were more than counterbalanced by the heavy expense to which they were put by the war between China and Japan. It was quite true that in their business they must be prepared for wars and rumours of war, but the reporting of the contest between the two rival powers in the Far East presented peculiar difficulties, and was attended with large outlays for special correspondents. The war, however, was now at an end, and he saw no reason why they should not be able to resume the payment of a dividend during the autumn, provided they were not again called upon to incur similar exceptional expense. The company gained the lawsuit to which he referred at the last general meeting, and was awarded sufficient damages to cover the legal expenses. Owing to various causes, which he need not specify, the proposed purchase by Reuter's International Agency of the company's advertisement branch on the original basis was not completed. They were now negotiating a fresh arrangement, but it would be prejudicial to the interests of the company were he at present to divulge the character of the subjects now under discussion.

The report and accounts were adopted.

Brazilian Submarine Telegraph Company, Limited.

—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended March 31st, 1895, and payable on June 22nd. The transfer books will be closed from June 15th to 21st, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 26th, 1895, amounted to £884; week ending May 27th, 1894, £931; decrease, £47; total receipts for half-year, 1895, £19,604; corresponding period, 1894, £19,144; increase, £460.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending May 20th, 1895, amounted to £1,135; corresponding week last year, £874.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 24th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,712.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. †	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, May 22nd.	Closing Quotation May 29th.	Business done during week ended May 29th, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	46 — 48	46 — 48	46	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	84½ — 85½	84½ — 85½	85⅝	85
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¼ — 8⅜	8¼ — 8⅜	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	12½ — 13	12⅜ — 13¼	13	12⅜
75,000£	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	154 —158	154 —158	160	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¾ — 10¼	9¾ — 10¼	...	...
30,000£	Do. do. 4½ % Debs. of £50, Nos. 1 to 1,600	...	...	...	4½%	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	9¼ — 9⅝	9¼ — 9⅝	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16½ — 16¾	16½ — 16¾	16¾	16¼
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17½ — 17⅝	17½ — 17⅝	17⅝	17⅜
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	105 —109	..	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	4 %	4 %	.	123 —126	123 —126	124⅜	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	16⅞ — 17⅛	16⅞ — 17⅛	17 1/16	16¾
54,100£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5 %	5 %	104 —108	104 —108	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	105 —108	105 —108	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —127	124 —127	...	...
95,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5 %	5 %	104 —108	104 —108	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	5 %	105 —108	105 —108	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	107½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114%	111 —114%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	...	10 — 10¼	10 — 10¼	10⅜	10
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅞ — 17⅛	16⅞ — 17⅛	17⅛	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21½ — 22¼	21½ — 22¼	22⅜	21⅜
190,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	106⅝	106
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	44 — 47	44 — 47	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	*nil*	4 %	...	1¼ — 2½	1½ — 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5⅝ — 5⅝	5⅝ — 5⅝	5 1/16	5 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½ — 16½	15½ — 16½	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14½ — 15½	14½ — 15½	15	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5⅛ — 6⅛	5⅛ — 6⅛	6⅛	5 1/16
1,100,000£	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 —106	104 —106	105¾	104¼
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	1/16 — 1/8	1/16 — 1/8	...	...
100,000£	Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109	106 —109	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½ — 4½	3½ — 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	123 —128	124 —129	127⅞	127
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	85 — 90	85 — 90	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	...	4½ — 5½	4½ — 5½	...	...
138,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	..	...	1½ — 2½	1½ — 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	100 —105	102	101⅞
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½ — 11	10½ — 10⅝xd	10⅝	10 1/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 6⅝xd	6 5/16	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4¼ — 4⅜	4¼ — 4⅜xd	4½	4⅜
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	103 —107	103 —107	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	7/8%	¼%	⅜ — 1	⅜ — 1	7/16	3/8
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	10¼ — 11¼	10 — 10½	10⅝	10¼
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	110 —113	110 —113	110½	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½ — 5⅝	5½ — 5⅝	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14 — 15	14 — 15	14⅝	14⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½ — 16	15½ — 16	...	...
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅜ — 7⅝	7⅜ — 7⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2 %	2½%	3 %	10½ — 11	10¾ — 11¼	11	10⅝
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	117 —119	118	117
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7½ — 8	8 — 8½	8¼	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	8¼ — 8⅜	8¼ — 8⅜	8⅜	8¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8⅜ — 9¼	8⅜ — 9¼	9 3/16	9¼
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7¾ — 8¼	7¾ — 8¼	8⅛	8

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, May 22nd.	Closing Quotation, May 29th.	Business done during week ended May 29th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅜ — 2⅝	2⅜ — 2⅝	2 7/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2¼ — 2½	2¼ — 2½	2½	...
125,000£	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	113 —116	113 —116	...	...
630,000£	City and South London Railway	Stock	⅝%	⅝%	1¼%	45 — 47	44 — 46	46	45
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2½ — 3	2½ — 3	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	5 %	no quotation	... — ...	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	½ — ¾	½ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1 — 1¼	1 — 1¼	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1½ — 1⅝	1½ — 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10 — 11	10 — 11	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	21½ — 22½	21½ — 22½	22 9/16	21 9/16
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	9½ — 9¾	9⅝ — 9⅞	9¾	9⅝
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14¾ — 15¼	14¾ — 15¼	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	41 — 43	42 — 44	43¾	42
150,000£	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	2½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.

Electric Construction Corporation, 6 % Debentures, 84—87.

Electric and General Investment, shares of £5 (£1 paid), 1¼—2

House-to-House Company (£5 paid), 3¼—4½.

Do. do. 7 % Preference, of £5, 7 —7½.

Do. do. 6 % Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7¼—7⅞; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7¼—7½.

London Electric Supply Corporation, £5 Ordinary, ¼—½.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 99—101 nominal.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¾—6.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

(*Continued from page* 646.)

Mr. JAMES STAATS FORBES said he was the President of the National Telephone Company, and represented the company to inform the Committee on all the facts of the service, and he would also be prepared with some answer to the charges against the company.

The CHAIRMAN: Perhaps you will inform us first on what day the company sent out its circular?—The County Council sent out theirs on Monday; we sent ours on the preceding Friday. The company's circular was: "Memorandum—I (or we) do not approve of the telephone service in the Metropolis being undertaken by the London County Council, and am satisfied that the service given by the National Telephone Company is reasonable, having regard to the efforts which are being made by the company to improve it by the adoption of the twin-wire system." The results were: signed unconditionally, 2,346; signed with qualifications, 266; signed in favour of London County Council, 43; refused to sign, 36. Number of exchange subscribers 8,208.

Mr. SNAPE: Did you send out any other document?—No.

Mr. BENN: The leading question was whether the subscribers approved of the service being undertaken by the London County Council. I submit it cannot be taken as evidence of any satisfaction with the service.

The CHAIRMAN: It goes on to say that.

WITNESS said the reports had become public that the London County Council had particular views on the subject, and they wished to ascertain the views of their subscribers.

The CHAIRMAN: I think the figures will speak for themselves.

Mr. SNAPE: You do not ask the question in any distinct form; you do not even ask them to send it back?—They do send it back.

Only about one-third sent it back?—As in the other case, the Council asked them to reply, and we did not.

In reply to the CHAIRMAN, the WITNESS said that with regard to the chronology of telephony, Bell's patent came into operation in 1876, and expired in 1890, and the Edison on July 30th, 1879, and expired July 30th, 1891. The Bell and Edison companies amalgamated as the United Company on May 13th, 1880, and the United Company started business on the same day. Then the Post Office awoke to the fact, and proceeded to establish a right, and a judgment in the Post Office action declaring the telephone to be a telegraph, and thereby covered by the Post Office monopoly, was given on December 20th, 1890. The first license to the United Company was granted on April 11th, 1881. That license was full of difficulties, no doubt prompted by the desire of the Post Office Department to protect the monopoly of the Post Office, but it existed for four years. The first license was for a very restricted area, and there were other restrictions. The second license to the United Company was granted on November 29th, 1884, and under that, the limitation of area was entirely removed. Then they began to find out what telephony really meant, and what it was capable of. Licenses were granted to the United Company and several other companies, notably to the Lancashire and Cheshire, the National, and others. Of course, no company was formed without a license from the patentee. The Postmaster-General licensed the area, but the licensee could not proceed to work in the area without a license from the patentee, so that there was a double check on expansion. His connection with the United Company began through his being called in to negotiate between the companies, and he was the author of the amalgamation in 1880. There were 13 licenses in all granted by the Postmaster-General, and all were subject to the operations of the two licenses. A great many companies were formed in local areas, and worked with their own directors and officials for a number of years. The first step to alter that was through the working of more important areas by the Lancashire and Cheshire Company and the National Company, which was a very large one, covering very many important places in England and Scotland. Then the trunk lines became more important, for they found that the local business depended a great deal upon the question whether it was to be purely local, or whether there could be communication from one centre to another. They found that a great many people did not think the local service of sufficient importance, and could only be induced to join the exchange if they had the facility of trunking outside the area. The trunks became very important, and it was greatly that which led to the amalgamation. They found that they were getting so tied up altogether, that they negotiated and bought the Lancashire and Cheshire and the National Companies. The United Company, the Lancashire and Cheshire, and the National, amalgamated on May 1st, 1889, under the name of the National Company. The parent company was the United, but they thought the National was rather a better title. Other affiliated societies had since been absorbed in accordance with the agreement negotiated with the Post Office in 1882.

The CHAIRMAN: You say under the obligations incurred by us to the Post Office?—Yes.

Under what document?—We were to be prepared to undertake that every one of these companies should be amalgamated with the National.

All these amalgamations had taken place before the agreement?—Yes.

Mr. BENN: The agreement of 1892?

The CHAIRMAN: As a matter of fact, at the time the agreement was

entered into between the National and the New Companies and the Post Office, all the licenses, with the exception of Ireland, were controlled by these companies?—Yes, that was so.

WITNESS, continuing, said that the result of the amalgamation of the three companies was that in view of the expiration of patents on May 1st, 1890, the subscription in Liverpool, Manchester and Warrington was reduced from £20 to £15; on July 1st, 1891, there was a general reduction of rates in the provinces from £15 and £12 to £10, involving an immediate loss of revenue of £58,000 per annum of the then number of subscribers.

The CHAIRMAN: Did that lead to much increase in the number of subscribers?

WITNESS said that when they amalgamated, the National had 10,013 subscribers; the United 6,773, and the Lancashire and Cheshire 6,230, a total of 23,836. In the first year the number was increased by 3,870 new subscribers, bringing the total up to 27,706 subscribers to the year ending April 30th, 1890. In 1891 they took in the South of England with 3,235, and the Northern with 1,851 subscribers—that was 4,786 taken over. During that year there was an increase on the other part of the business of 6,183, making the total increase 10,969, and the total subscribers 38,675. In 1892 there was no other company brought in, but the increase in the number of subscribers was 7,788; in 1893 they took in two companies with 5,442 subscribers, and the increase on the other part of the business was 7,126, a total increase for the year of 12,168. In 1894 they took the Irish business of 1,550 subscribers over, and they had 7,825 new subscribers; therefore, from 1890 to 1894, they increased from 27,706 to 78,353.

The CHAIRMAN: You say in 1893 you acquired a company; I thought you said that in 1892, at the date of the agreement, you had practically acquired all the companies?—I must correct that statement.

Continuing, WITNESS said to show the development of the company up to April, 1895, he might state the number of towns and places supplied was 537; number of exchanges open 593; number of subscribers' lines 75,216; number of telephones in use 86,032; present ratio of effectual calls per annum 139,639,032, equivalent to (at least) 279,278,064 messages; average annual payment per line, £9 2s. 2d.; average cost to subscribers per message, ·58d.; estimated minimum average number of words per message, 100; average annual payment, £9 2s. 2d.; average per week, 3s. 6d.; average per day, 6d. That answered the question as to whether the charge for the service was at an extravagant rate. Of course, the average of £9 2s. 2d. per line was brought about by subscribers having more than one line and being charged less. They were bound to fix it in that way to get a reliable figure—they must lose it on the earning of the wire. He meant a wire which had a telephone at the end. If a subscriber had three telephones in his house but only one wire, that was counted as one wire; but if there were three telephones and three wires, that was three wires. They would find that in a three minutes' conversation 400 words would be spoken, so that the message worked out at ·58th of a penny, which could not surely be called an extravagant figure. To the person who had taken the trouble to learn the telephone, the price was ridiculously low. The average cost worked out at 6d. a day, including Sundays, because they could telephone on Sundays, and they could telephone all day to every place, and to a great many places all night. Therefore every subscriber had the use of the telephone all day, and generally all night, for the price of a 6d. telegram—100 words telegram cost 4s. 2d., and the cost of the telephone for 100 words to a subscriber cost about ·58th of a penny. As regarded the comparison of charges with those of other countries, he would like the committee to consider how important it was to know in matters of that kind what the facts were, and to know how to apply them to the circumstances. When they came to apply them to New Zealand or Stockholm, circumstances were different. They must know the condition of those places, and what the telephone meant in one case as compared with another, before forming any opinion of its relative value or its relative use. Their subscription averaging £9 2s. 2d. was said to be extravagant, and leaving out of the question of more or less efficient service, was it extravagant? He did not think it was. But if it was extravagant, was it their fault? He did not think it was. The question to ask was, "What could this charge be on the assumption that the National Company were relieved from these direct and extraneous charges not pressing, or very slightly pressing, upon State telephones abroad? These are (*a*) royalty, wayleaves, rates and taxes; (*b*) greater relative scales of salaries, wages, &c." In the year ending December 31st, 1894, the working expenses of the National Company amounted to £456,809 15s. 4d., or 62 per cent. of the telephone revenue. The charges under (*a*) amounted to £147,938 10s., which equalled 20 per cent., and the charges under (*b*) amounted to £214,123. Now, with regard to the heading under (*b*) wages in England were relatively higher than abroad, and although he regretted it from a sentimental and patriotic point of view, they were obliged to go to Germany to get the best wire. He would bring that home to them by showing them what the charges under (*b*) amounted to. Of the £214,123, £93,537 went for line and instrument repairs, and 72·88 of that went for labour, which came to £68,157. The wages paid in Great Britain for skilled labour were 33 per cent. higher than abroad, which meant £22,719 added in wages. Now, as to salaries of the staff, the salaries of operators was, if anything, a little less than abroad, but these were the market price, and they had 20 applicants for one vacancy. But with respect to the higher class of employés: the salaries, what they called brains, that was 30 per cent. higher than abroad, being equal to £36,160. Adding that with the higher wages of labour, the result was £58,879. Now, to apply these figures. The average annual payment of subscribers was £9 2s. 2d.; the working expenses averaged £6 4s. 7d.; the items mentioned as higher than abroad came to £2 16s. 3d., and if that was taken from the annual subscription, it would bring it down to £6 5s. 11d. He would now go into points which affected the efficiency of the service, for he thought he had disposed of the price. It was misleading to compare London with Stockholm or Berlin. They must consider the relative position of the telegraph and the telephone. In Sweden the telegrams sent only averaged 13·7 per 100 inhabitants, and in Great Britain it was 177·1 per 100; whilst in Berlin it was only 55 per 100.

The CHAIRMAN: You mean that where there is a very efficient telegraphic service you would not expect to find such a large demand for the telephone service?—Yes, that is so.

By Mr. SNAPE: The number of towns in Germany having telephones was 440; the number of telephones was 91,458; number of subscribers, 84,109; number of conversations, 391,388,000. The business in Germany had been in the hands of the State from the beginning, and had all the prestige which attached to a Government department, but still in England they had made almost as much progress with all the restrictions.

Continuing, WITNESS said he did not see why the numbers in London should be called relatively small. First of all there was enormous use of the telegraph in London; then there was the multiplication of the delivery of letters, and then there was the habits of the people. He had lived in many towns on the Continent, and he did not know any city where the tradesmen called as they did for orders and brought them home. Then as to the badness of the service, it must be remembered they brought the service into the country, and they had to train their own people. Of course, they had made mistakes, and if they had been as wise as they were now, they would not have the single-wire system. But Berlin, which was set up as such an example, had a single-wire system. Now, as to the metallic circle, he had prepared a statement showing what they were doing in that way. It was as follows:—

"Number of exchanges fitted or in process of fitting with complete metallic circuit wires and switchboards, 117, representing a total of 18,978 subscribers' lines; number of exchanges fitted with metallic circuit switchboards not included in above, 78, representing a total of 20,995 earth circuit lines; number of metallic circuit subscribers working on metallic circuit and earth circuit switchboards not included in above, 706; number of exchanges fitted with earth circuit switchboards and lines, 398, representing a total of 22,485 subscribers' lines. Total, 593 exchanges; 63,164 exchange lines. Number of exchanges in process of erection on metallic circuit principle, but not yet opened, 18. Total number of exchanges, 611.

"The principal exchanges in the following towns are now fitted (or in process of fitting) with metallic circuit switchboards, which represents the main work of transfer from the earth return to the metallic return system, the remaining work, namely, that of duplicating subscribers' wires, is dependent largely upon wayleave facilities being afforded especially by local authorities:—London (Central) (Lime Street) (Queen Victoria Street) (Holborn) (King's Cross) (Eastern) (Tilbury) (Dalston) (Stratford) (Gerrard Street) (Westminster) (Kensington) (Edgware Road) (Kilburn) (Ealing) (Battersea) (Balham) (Clapham) (Deptford) (Dartford) (Marshalsea Road) (Kingston) (Peckham) (Richmond) (Wimbledon) (Woolwich) (Croydon) (Sydenham) (Bromley) (Streatham) (Redhill) (Epsom) (Sutton), Glasgow (Royal Exchange) (Hillhead), Leith, Dundee (Central), Greenock, Bridge of Wier, Inverness, Kirkcaldy, Dysart, Banff, (Keith) (Macduff), Aberdeen (Central) (West End), Middlesboro' (Stockton) (Saltburn) (Redcar) (Linthorpe) (Norton) (Eaglescliffe) (Yarm), West Hartlepool, Hartlepool (Seaton Carew) (Greatham), Durham, Bishop Auckland, Consett (Shotley Bridge) (Leadgate), Chester-le-Street, Darlington, Newcastle (Quay Side) (Jesmond) (Byker) (Elswick) (Gosforth) (Gateshead) (Low Fell) (Wallsend) (Blaydon), Hexham (Corbridge), Alnwick (Alnmouth), Berwick, Blyth, Morpeth, Sunderland (Seaham) (Houghton) (Ryhope) (Hylton) (Boldon), South Shields (Jarrow), North Shields (Tynemouth) (Whitley), Hull (Billingsgate), Leeds (Roundhay) (Headingley), Dewsbury (Cleckheaton) (Heckmondwike), Liverpool (Central) (Sefton Park) (Waterloo) (Wavertree) (Lark Lane) (West Derby) (Liscard) (Rock Ferry) (Claughton) (Neston) (Upton) (Heswall), Ormskirk, Manchester (Central) (Altrincham), Blackburn (Accrington), Burnley, Preston, Lancaster (Morecambe), Kendal, Oldham, Buxton, Bolton, Warrington, Widnes, St. Helens, Wigan (Ashton-in-Makerfield) (Newton-le-Willows), Chester, Llandudno (Colwyn Bay), Northwich (Middleswich) (Winsford), Wrexham (Ruabon), Crewe, Wolverhampton, Birmingham (Acock Green) (Brierley Hill), Leicester (Stoney Gate), Newark, Northampton (Wellingboro') Lincoln, Sheffield (Central) (Thorne), Norwich, Lowestoft, Cambridge, Peterboro', Reading (Henley), Slough (Maidenhead) (Marlow), Guildford (Godalming) (Aldershot) (North Camp), Watford (Rickmansworth), St. Alban's, Brighton, Canterbury, Ramsgate, Folkestone, Chatham (Rochester), Maidstone, Sevenoaks, Gravesend, Southampton, Fareham, Plymouth (Devonport) (Mutley) (Ivybridge), Cardiff (New Street) (Working Street) (Docks) (Penarth) (Barry Docks) (Llandaff), Pontypridd, Aberdare (Merthyr), Pontypool (Tredegar), Bridgend, Newport, Lydney, Chepstow, Swansea (Morriston) (Mumbles), Llanelly, Port Talbot (Neath) (Briton Ferry), Bristol (Stoke Bishop), Gloucester (Brinscombe) (Stonehouse) (Nailsworth) (Stroud), Taunton, Sharpness, Dublin (Killiney) (Dundrum), Londonderry (Brookhall).

The modern boards at Glasgow have cost upwards of £19,000, and further extensions are in progress; the work of completing metallic circuiting the entire metropolitan system has, during the past three years, been most actively pushed forward, about 75 per cent. of the work is completed, and it is anticipated that the whole will be finished at the end of the present year. The cost of this work will be about £200,000."

They admitted that Glasgow was not a good service, but they were ready to give a good service if the local authorities would help them. Two years ago he stated that the service was bad, but they could not introduce the metallic service in a day. Then as to the question of

competition, there had been much speculative talk, but they had an illustration in Manchester. The Mutual Company's exchange was opened in Manchester on February 28th, 1891, and the number of subscribers to the company at opening was 170. The number of subscribers to the New Telephone Company (late Mutual) at end of April, 1895, was 1,349. The number of National Company's subscribers at the date when the Mutual Company commenced, February 28th, 1891, was 1,944; number of National Company's subscribers in Manchester and Bolton at end of April, 1895, was 3,374; number of National Company's subscribers who gave up the National to join the Mutual was 27; number of National Company's subscribers who were also New Company's subscribers at end of April, 1895, was 492; analysis of rates paid by New Company's subscribers:—501 at £10, 20 at £8, 709 at £6, 119 at £5.

The CHAIRMAN: While competition lasted there were two distinct sets of subscribers, and they could not get on to one another's lines?—Yes.

Mr. SNAPE: Would the same thing apply in the case of municipalities obtaining licenses?—If the municipalities worked irrespective of profit and loss, and the ratepayers did not object, the position of the company would be a little awkward; but he did not anticipate that.

Mr. FORBES then briefly commented upon and handed in the two following papers, the first dealing with the increase in the number of subscribers in the four large Scotch towns in the last five years, and the other with the number of complaints.

Statement showing increases in the numbers of subscribers in the four large Scotch towns during the last five years.

	Year ending March 31st.	Number of lines.	Increases in lines.
GLASGOW.—	1890	2,652	—
	1 91	3,374	722
	1892	4,247	873
	1893	4,651	404
	1894	4,938	287
	1895	5,292	354
	Total increase during last five years		2,640
EDINBURGH.—	1890	746	—
	1891	913	167
	1892	1,207	294
	1893	1,379	172
	1894	1,553	174
	1805	1,787	234
	Total increase during last five years		1,041
DUNDEE.—	1890	837	—
	1891	937	100
	1892	1,023	86
	1893	1,120	97
	1894	1,224	104
	1895	1,309	85
	Total increase during last five years		472
ABERDEEN.—	1890	584	—
	1891	626	42
	1892	726	100
	1893	775	49
	1894	923	148
	1895	1,063	140
	Total increase during last five years		479

Statement of Number of Complaints by Subscribers for Year 1894.

Name of district.	Average number of complaints per exchange subscribers' line for year ending December 31st, 1894.	Average number of exchange messages, local and trunk, per exchange subscribers' line for year ending December 31st, 1894.
Glasgow	3·79	4,488
Edinburgh	·09	4,546
Dundee	·03	5,322
Aberdeen	1·49	4,644
Greenock	·55	2,751
Galashiels	·10	2,696
Kirkcaldy	·26	2,812
Kilmarnock	·48	1,831
Hamilton	·36	3,313
Dumbarton	nil	1,434
Falkirk	·73	3,945
Dumfries	07	1,992
Inverness	·24	1,722
Oban	nil	712
Newcastle	·60	3,555
Middlesboro'	·54	4,403
Hull	·43	3,855
Leeds	1 02	7,101
Bradford	·89	5,763
Liverpool	2 16	7,290
Manchester	1·56	8,663
Blackburn	·34	2,966
Oldham	·28	3,227
Bolton	2 47	3,697
Warrington	1·61	4,137
Whitehaven	·24	2,474
Chester	·71	1,623
Douglas	·10	3,687
Birmingham	·38	3,949
Hanley	·65	5,564
Nottingham	·71	4,025
Sheffield	·31	3,430
Norwich	·78	1,894
Reading	·29	2,346
Brighton	·91	2,690
Canterbury	·71	1,105
Southampton	·47	3,090
Plymouth	1·28	3,251
Cardiff	·39	3,205
Bristol	1 05	4,026
Belfast	·47	5,703
Dublin	1·30	2,735
London	·94	2,944
Average of United Kingdom	·73	3,595

The number of messages is arrived at by treating each subscribers' call when put through as being two messages, *i.e.*, question and reply.

The messages are "Exchange" line messages only, as the company has no means of ascertaining the number of "private" line messages, which would be additional to the above figures. The number of complaints in Glasgow was greatly increased by a change of working, which was effected early in 1894. The complaints include the private lines as well as the exchange lines.

Coming to the question of charges of other countries, WITNESS said that Mr. Dickinson was wrong in stating that the tariff in Holland was as low as £2—it varied from £9 to £20 odd, and the space covered was 30 square miles, whereas in London it was 600 miles. He put in the following statement of foreign telephone tariffs:—

STATEMENT OF FOREIGN TELEPHONE TARIFFS.

Company or State.	Place.	Tariff.	Royalty.	Free speaking area.	Number of subscribers.
Company...	Baltimore U.S.A.	£ 32 0 0 = Dollars (160)			
" ...	Boston "	36 0 0 = (180)			
" ...	Chicago "	35 0 0 = (175)			
" ...	Cincinnati "	24 0 0 = (120)			
" ...	Pittsburg "	27 15 0 = (138)			
" ...	Providence "	24 0 0 = (120)			
" ...	Rochester "	24 16 0 = (124)			
" ...	Washington "	32 0 0 = (160)			
" ...	Philadelphia "	32 0 0 = (160)			
" ...	New York "	48 0 0 = (240)			
" ...	Albany "	20 0 0 = (100)			
" ...	Hartford "	25 0 0 = (125)			
" ...	Worcester "	21 0 0 = (105)			
" ...	Troy "	20 0 0 = (100)			
" ...	Brussels	Single wire £10 within a radius of 3 kilometres of the exchange; £2 for each kilometre beyond this distance, and £1 13s. 4d. for each extra kilometre.	None ...	City of Brussels ...	2,400
" ...	Amsterdam ...	£9 16s. 8d. for 1 kilometre ... ... Note.—Service from 8 a.m. to 10 p.m. only. Houses in the suburbs, such as Neuwer-Amstel, £12 10s. Houses in the Ouder-Amstel, £20 16s.	None ...	About 30 square miles	4,344
State ...	Geneva	£4 15s. 2d. first year; £4 second year; £3 4s. 2d. for each year following within 3 kilometres of the exchange, with an extra charge beyond this distance of 3 francs for each 100 metres. The above tariff only gives the subscriber a right to 800 conversations per annum; beyond that number an extra charge is made of 5 francs for each 100 or part of 100 conversations.	None ...	250 square kilometres...	About 2,600

STATEMENT OF FOREIGN TELEPHONE TARIFFS—*Continued.*

Company or State.	Place.	Tariff.	Royalty.	Free speaking area.	Number of subscribers.
State ...	Berlin	£7 10s. within a radius of 3 kilometres; beyond this distance 3 marks for each 100 metres.	None ...	Within a radius of 5 kilometres from the central exchange.	22,070
Company...	St. Petersburg ...	£39 11s. within about 2 miles	... ...	St. Petersburg... ...	1,944
„ ...	Lisbon	£10 within 1 kilometre of the exchange	3 per cent.	The area is included in a radius of 30 kilometres from the exchange	1,106 includes private lines.
State ...	Paris	£16, and subscribers pay for instruments and for keeping same in repair.	None ...	City of Paris	28,092 in the whole of France.
„ ...	Adelaide	£10 per annum within 1 mile	None ...	City of Adelaide.	
„ ...	Sydney	£12 per annum within 1 mile	None ...	City of Sydney.	
„ ...	Melbourne ...	£12 per annum within 1 mile	None ...	City of Melbourne.	
Company...	New York	£48	None ...	Manhattan Island, area about 20 square miles.	
State ...	Vienna	£10 within radius of 2 kilometres	... ...	Radius of 15 kilometres	7,900

The Committee adjourned till Friday.

USES OF ACCUMULATORS.*

BY J. C. HOWELL.

(*Concluded from page* 661.)

LET us pursue our investigations a little further, and we will see that during the period of lighter load 6,385 lbs. of coal were consumed, an amount sufficient working at the rate shown during the period of maximum demand to produce 1,050 units, or very nearly the *total daily output required.* Had we been therefore only able to provide some suitable means of storage which would have allowed us to run our engines at a fair rate of economy, there was a possible chance on that day's output of effecting a saving of two tons of coal during the run, or say £2 sterling, an amount which would perhaps go some little way towards meeting the resident engineer's salary.

That there is a practical difficulty in so running a central station plant as to work it with anything like a fair efficiency, no one but a central station engineer has fully realised, and I should like here to emphasise what I have long felt, that we hear too little of the central station engineer. It may be that the exigencies of his work preclude him from attending meetings and speaking thereat, and I can well understand that the problems continually thrust upon him absolutely forbid his devoting much time to writing papers, but, if he only realised what service he could render to the manufacturers, who are always anxious to supply him with what he wants, he would, I think strain a point, and give the world knowledge of his necessities. To give you some conception of the problem that the resident engineer has to solve, I prepared a diagram showing the output of an American station, which I visited some time ago, and I plotted in the way in which the load was dealt with.

The plant at their disposal was capable of dealing with a maximum output of some 18,800 ampères made up in four sets of 2,000 ampères each, and nine sets of 1,200 ampères. At no time during the day did the station touch an engine load factor of 80 per cent. except for a few minutes at the peak of the diagram. Starting at one o'clock in the morning, set No. 15 was kept running nearly the whole 24 hours; set No. 11 ran from one o'clock till half-past nine, and, carefully noting the level that No. 11 set combined with No. 15 would have taken, it was observed that during the whole period of minimum demand the engine load factor did not reach even 60 per cent. as an average. Further at seven o'clock, when the load commenced to rise, the additional load had to be dealt with by adding small set after small set, and it was only when the load was rising so rapidly near the peak were they able to fully utilise the larger sets which ought *a priori* to be more economical to run than the smaller sets. The same criticism will apply on the down grade when the demand was decreasing. The coal consumption at this station on the day on which the curve was taken was 80 tons. The two larger engine sets were kept going at as near their maximum output as in American practice is considered safe, taking the sudden abnormal changes of load into account, and the balance of the load was equally divided over all the other sets that were at the time running. The result of this complicated system is that although by the number of engines running the efficiency of each is somewhat increased, the regulation of the pressure on the mains is more difficult, as the adjustment to standard is only really effected when the current from the last machine is properly adjusted. That the labour involved in this adjustment is considerable is easily understood.

I find that almost all our later knowledge with regard to the varied load line have been duly considered, and methods are described very fully by which the use of accumulators would relieve the central station engineer from all anxiety as to his variable demand, and I have prepared a chart showing how the methods would deal with the load curve which I have put before you. We are told that we must first ascertain the output for the period of minimum demand, and for what time the minimum demand lasts. These figures enable us to ascertain the capacity of the accumulators required. We observe that this period of minimum demand is very clearly defined on our load curve as lying between 1 a.m. and 7 a.m., a period of six hours. During this time an average of 2,100 ampères have been delivered to the circuit or, say, in round figures, a total of 13,000 ampère hours. To provide for this output and allow a margin for contingencies, we shall require a set of accumulators having a capacity of 14,000 ampère hours. An enquiry addressed to modern accumulator manufacturers has brought me the information that such a battery would cost delivered and erected £7,000.

On adding this battery to the equipment of the station I find that the result upon the working of the motorial part of the machinery is that whenever an engine is started it can be kept at full load from the moment it starts to the moment it ceases running, thus bringing up the efficiency of the station to 100 per cent. engine load factor at once.

Observe the result. Instead of the patchwork jumble of in and out engine loads, we have each set working steadily at full output as long as is required; and the hours of running have been shortened from 24 to 18, thereby lessening the number of men employed. More than this, we have been able to commence running with three of our large sets at full load from the moment of starting up to 7 a.m., and these engines run steadily throughout the day. We notice also that when the load increases the accumulators, although discharging during the early morning hours, have already received sufficient charge to permit a discharge until three more engine sets can be started simultaneously, pointing out the advisableness of employing fewer sets of larger plant for this station.

The only regulation required is the steam pressure at the boilers which must be kept constant, and a slight increase in the speed of the engines as the load creeps up to compensate for the slight additional loss in potential in the feeders leading the current away from the station.

Follow the curve still further, and we come to a period when the engineer has to exercise his judgment as to whether he will let his battery deal with the peak, or run one of his engine sets. He chooses the former course, and to provide for it he starts one set, and keeps it running for several hours before the peak actually occurs. You will observe that at the time when this peak is about occurring, he again starts three sets simultaneously, and the peak itself is allowed to come from the battery. Three times during the day, therefore, has he to start some plant, and in each case you will observe that he has been able to put on three sets. Only once is it necessary for him to start one of his engines alone.

Now I shall very probably be told that owing to the variation in the E.M.F. of the battery during charge, the regulation of the charging current will be an exceedingly difficult matter, but this regulating matter is exceedingly simple. One of the steam dynamo sets is expressly made to give just the current rate necessary for properly charging the battery and no more. The set devoted to this work in the station before us is No. 15. This set is capable of charging the battery at 2,000 ampères, and the dynamos are so wound that when necessary higher volts can be obtained from this set than from the other sets. It is the first to be started up, and it is the last to leave off, and is, during the whole day, prepared to charge the battery except at the time when the output called for is in excess of the current generated by all the sets in combination. It is kept permanently attached to the regulating ends of a battery. An adjustable switch is so arranged that the terminals of the machine can be attached to any cell in the regulators, so that as the end cells get charged up the switch may be moved down until it reaches the cell which is in connection on the discharge side with the terminals of the other sets and with the circuit.

You will note, also, that the loss in charging the accumulators is very slight, as it is only felt by one unit of the plant, and is really in the load diagram only 1 per cent. of the total load delivered to circuit, as the proportion between the load dealt with by the accumulators and the total output is just slightly over 8 per cent. But what have we gained? Even the most casual glance will show you how immensely simplified the station work has become, a certain number of engines running, a certain amount of steam required, the engineer in charge directing everything with quiet confidence, knowing full well that he has a big reserve always behind him capable of dealing with an extraordinary demand, or with any little accidental occurrence such as a hot bearing or low steam pressure. In a well regulated central station with a becoming amount of pride such accidents should, I am aware, never happen, but I am credibly informed that they do sometimes occur.

* Paper read before the Northern Society of Electrical Engineers, May 13th, 1895.

But these after all are only minor advantages. No board of directors has yet, so far as I am aware, sanctioned an item for depreciation of engineering staff appearing on a balance-sheet, and we must look for more solid grounds of economy before we can appeal to them. A comparison made between the two curves will at once show you that the labour bill will be considerably reduced by the employment of accumulators, and the amount of the saving is thus shown by Table 2 to be £1 15s. 6d. a day.

STAFF REQUIRED TO WORK CENTRAL STATION.

Without Accumulators.				With Accumulators.			
	£	s.	d.		£	s.	d.
10 greasers at 4½d. ...	1	7	6	8 greasers at 4½d. ...	0	18	8
6 engineers at 8d. ...	2	0	0	5 engineers at 8d. ...	1	10	0
11 stokers at 5½d. ...	2	10	5	9 stokers at 5½d.	1	17	1
3 switchboard attendants at 8d. ...	0	16	0	3 switchboard attendants at 8d....	0	16	0
				2 battery men at 8d. ...	0	10	8
30	£7	3	11	27	£5	12	6

* Difference:—£1 15s. 6d.

The coal bill will also shrink as we have ceased running our engines during the period when we are using our coal most wastefully, and moreover we are able to run our engines at full load whenever they are running. Carefully working out the amount of coal required for each engine, we shall see that we have brought down the amount from 80 tons, which I have mentioned as being the amount consumed on the day on which this load curve was taken, to 67. Our oil bill and petty stores have also been reduced in almost the same proportion, and it is probable our bill for repairs to the motorial portion of our plant will be decreased somewhat, although this I will not at present take into account. You will also have observed that three engines that were at work in the first curve have not been required to run at all in the station when fitted with its accumulator system. We thus save the lubrication bill on these engines entirely, and the saving has been therefore:—

	£	s.	d.
Labour bill	1	15	6
13 tons of coal	13	0	0
Lubrication, say	0	4	6
Repairs	0	0	0
	15	0	0

But in order to effect this saving we have been compelled to make an outlay of £7,000 in a class of plant which, in the minds of most engineers should submit to a heavy charge for depreciation. We have not forgotten this, and will therefore set aside a sum sufficient to meet the views of these engineers by putting on the other side of our account an amonnt of £2 per day for depreciation, and £1 per day for interest on the outlay.

The extra staff required to look after the accumulators has already been dealt with in our labour table. The net saving therefore is reduced to £12 per day, or, say, £4,380 per annum, an amount sufficient to wipe off the whole capital cost of the accumulators in two years, and still leave a margin to go to the profit and loss account. The load curve is dated June 23rd, and you will readily understand what this means.

Now these figures are facts, and can be proved up to the hilt. They do not admit of argument, and since they apply to a station arranged on a scale very much larger than anything we have hitherto built in this country, they effectually dispose of the usual modern criticism that accumulators may be very well adapted for small stations, but are absolutely inapplicable to supply stations dealing with large outputs.

Another criticism, and a fairer one, would be that by taking coal at a value of 20s. per ton I have exaggerated the saving on the capital outlay. This is true, but those who care to puzzle out the problem will find that the economy is sufficiently marked at any value for coal to warrant the adoption of accumulators, and they will also find that the only satisfactory method of doing away with accumulators entirely is to work up their demand curve to a straight line extending over the whole 24 hours, an occupation which the old scribe quaintly observes "will take them all their time."

It will be seen, therefore, that wherever there exists an intermittent demand for a supply of electricity an electrical storage system is a necessity, unless the cost of the initial power is so abnormally low that the interest charges on the accumulator outlay amount to more than the annual saving to be effected. Such causes do sometimes occur when an abundant supply of water is available close at hand.

Intermittent demand for power is the rule in the majority of our manufactories to-day, and although hitherto we have been content to meet this demand by transmitting our power by means of steam pipes, countershafting, and belting, the day is not far distant when electrical methods of transmission will be the rule and not the exception. All these cases point to the application of accumulators, and you will readily perceive from what has already been said that to obtain the utmost economy accumulators will be absolutely necessary, for they enable us to reduce the initial power put down, and furthermore permit us whenever the utilisation of the power takes place some distance from the spot where it is generated to economise in the conductors, as they need not be of a sectional area greater than will carry the average current instead of the maximum with efficiency.

In this district, where underground transmission of power is becoming more and more common in all your collieries, you will assuredly find in the near future batteries of accumulators installed in the underground galleries in chambers, the difference in value of the highly insulated conductors leading in-bye having been found to cover the cost of the system of storage, without taking into account at all the other economies found to exist in the maintenance of the plant. Already electric railways have adopted electrical storage systems for equalising their load and maintaining more equal potential over their lines, thus ensuring a regularity of train service not to be attained by any other means.

I could go on pointing out numberless other instances where accumulators would be of the greatest service, but our time is already far spent, and I shall not weary you to-night by elaborating the matter further. There is, I think, a sufficient basis of fact to warrant our seriously considering whether the methods we are to-day adopting for dealing with the electrical supply of towns are in the majority of cases the most suitable methods, and I feel sure that the question of coal economy has not been gone into with anything like the care it should be in the design of many stations now at work and in course of construction. The high coal bill shown in many districts where coal is cheap is sufficient evidence of this.

* Some mistake has occurred in the casting up of these figures.—EDS. ELEC. REV.

NEW PATENTS—1895.

9,406. "Improvements in electric switches." G. HILL. Dated May 13th.

9,429. "Improvements in apparatus for electrolytical purposes." H. GUTHRIE. Dated May 13th.

9,433. "Improvements in electrically signalling on locomotives and apparatus for that purpose." R. BURN and L. G. TATE. Dated May 13th.

9,442. "Improved means for insulating electric conductors." G. G. M. HARDINGHAM. (Communicated by the firm of Felten & Guilleaume, Germany.) Dated May 13th.

9,445. "Improvements in electric meters." A. PELOUX. Dated May 13th.

9,478. "Improvements in heating and cooking by means of electricity." G. S. RAM. Dated May 14th.

9,504. "Improvements in shades or reflectors for incandescent electric and other lamps." A. A. BARRATT and THE ARTISTIC LETTER COMPANY, LIMITED. Dated May 14th.

9,513. "Improvement in electric lamps." W. H. SHEPPARD. Dated May 14th. (*Complete.*)

9,515. "Thermo-chemical processes for generating electricity." R. D. CASSELLS and G. DOWIE. Dated May 14th.

9,521. "A photographic telegraph recorder (Ader's system)." J. IMRAY. (Communicated by La Société Industrielle des Telephones and C. Ader, France.) Dated May 14th.

9,546. "Improvements in or relating to conduits for electric railways." E. LACHMANN. Dated May 14th.

9,547. "Improvements in and relating to the attachment of an electric lamp to a cap or the like." H. H. LAKE. (Communicated by A. Rodriques and E. D. Rockwell, United States.) Dated May 14th. (*Complete.*)

9,582. "Improvements in electrical apparatus for transmitting signals between points or stations, such as street fire-alarm apparatus." E. G. PULFORD. Dated May 15th.

9,636. "Improvements in electric arc lamps." SIEMENS BROS. AND CO., LIMITED, and F. BOOKER. Dated May 15th.

9,683. "Improvements in apparatus for lighting railway carriages by electricity." R. BELL. Dated May 16th.

9,684. "An improved commutator." W. J. HARLING. Dated May 16th.

9,685. "An improved brush-holder for dynamo-electric machines and motors." W. J. HARLING. Dated May 16th.

9,695. "A new or improved hand electric gas lighter." J. S. RICHARDSON and S. JEVONS. Dated May 16th.

9,698. "Improvements in electrically-driven pumps and in apparatus therefor." C. B. CRAWSHAW and R. KENNEDY. Dated May 16th.

9,704. "Improvements in electric track switches." J. Y. PORTER. Dated May 16th. (*Complete.*)

9,708. "Improvements in electric heaters or rheostats." J. H. DELANEY. [Date applied for under Patents, &c., Act., 1883, Sec. 103, November 23rd, 1894, being date of application in United States] Dated May 16th. (*Complete.*)

9,727. "Improvements in and relating to telephones." Sir C. S. FORBES, Bart. Dated May 16th.

9,730. "Improvements in electric igniting apparatus for gas and oil lamps and burners." J. T. ARMSTRONG. Dated May 16th.

9,779. "An improvement in secondary batteries." W. MATHER. Dated May 17th.

9,784. "Improvements in electrodes, pencils, filaments, or the like for electric lamps of all kinds." F. LE ROY. Dated May 17th. (*Complete.*)

9,796. "Improvements in conduits for electric cables." J. BONTHRON, W. HART, and J. S. LUCAS. Dated May 17th.

9,806. "Improvements in diaphragms for use in electrolytical apparatus." R. Comboul. Dated May 17th.

9,816. "Electric carriage wheel contact." E. Robinson. Dated May 18th.

9,850. "Improvements in electrical switches." C. M. Dorman, R. A. Smith, and H. G. Baggs. Dated May 18th.

9,864. "An improved automatic safety clutch applicable to the suspension of electric arc lamps and for other purposes." R. C. Quin and G. J. Philpott. Dated May 18th.

9,882. "Improvements in and connected with conduits for electric light wires and the like." The Safety Tread Syndicate, Limited, J. Mason, and J. Mason. Dated May 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

3,109. "An electric locomotive for combined adhesion and rack traction." J. Imray. (Communicated from abroad by F. Rinecker, of Wurzburg.) Dated February 13th. From a conductor laid along the line, or from storage batteries on the locomotive, electrical currents are applied to drive an electromotor, the armature of which can be connected by suitable gear and clutches to either the axle or axles of the adhesion wheels alone, or to both these and the pinion axle or axles; or there may be two separate electromotors, the one for driving the adhesion wheels, and the other for driving the pinions. The locomotive mechanism may be on a vehicle, or there may be a separate locomotive carrying the mechanism and coupled to a vehicle or train of vehicles. 3 claims.

3,217. "Improvements in electric arc lamps." H. F. Joel. Dated February 14th. Consists in improvements in the form of arc lamps made on what is known as the Pilsen-Joel type, having coned or spindle-shaped iron cores working between two solenoids, and balanced between them, to make an arc of the required length by the action of the electric current itself. 5 claims.

3,294. "Improvements in electric lighting apparatus for gas burners." M. Peterson. Dated February 15th. Relates to apparatus for lighting by means of electricity the gaseous mixture issuing from a Bunsen or other atmospheric burner with which an incandescent body, for instance an Auer hood, is used for illuminating purposes. The principal object of the invention is to save the incandescent body from injury when it is being fitted on the burner, as well as during the use of the apparatus, and for this purpose the break in the electric circuit that causes the spark is arrranged within the said incandescent body. 3 claims.

3,324. "Improvements in magnetic compasses of the kind known as the 'trough' compass." P. J. Dixon. Dated February 16th. Consists of a magnetic compass, the body or case of which is of suitable metal, oblong shaped, the top and bottom being of glass, talc, horn, or other similar transparent substance, enabling the details of a map to be seen through it; or so that on a dark night the points of the compass may be distinctly seen by the diffused light of the clouds upon its being held above the head. 3 claims.

4,325. "Improvements in the electro-deposition of aluminium." A. H. Harris. Dated March 1st. Claims:—1. The described improved solution for use in the electro-deposition of aluminium, the said solution being made from nitrate of aluminium, ammonia, and bisulphite of soda combined together and treated in the manner substantially as set forth. 2. In the electro-deposition of aluminium on metals or alloys, or other substances, the employment, in combination with the aluminium anodes in an electroplating bath, of the described improved solution made from nitrate of aluminium, ammonia, and bisulphite of soda combined together and treated in the manner substantially as described, and either with or without the addition of a little cyanide of potassium, as set forth.

4,366. "Improvements in dynamo-electric machines." A. J. Boult. (A communication from Compagnie de L'Industrie Electrique, of Geneva.) Dated March 1st. Claim:—A dynamo-electric machine characterised by the disposition of the walls or surfaces which limit the air space, one of which is smooth, and the other one toothed, and the one of said surfaces being movable with regard to the other, the induced coil being placed on the smooth surface, and the said disposition having for its object to cause the intensity of the magnetic field to be made variable in the air gap without causing any variation in the total flux created by the exciting current.

4,554. "Improvements in telephony and telegraphy." C. Adams-Randall. Dated March 3rd. Consists mainly of a main or transmitting battery divided into sections, and having circuit connections therefrom to the transmitting instrument; a specially constructed speech transmitting instrument, together with means for signalling or telegraphing. 6 claims.

4,572. "Improvements in telephonic transmitters." C. Adams-Randall. Dated March 5th. Consists generally in the use of a suitable diaphragm either of carbon or carrying or vibrating a carbon electrode, which, in either case, forms a part of the circuit; the diaphragm is suitably held in any of the well known ways, and preferably in a horizontal position. Suitably suspended over the diaphragm, in independent sections, and insulated from each other and from the diaphragm electrode, and upon separate supports or on a support common to all, are provided tubes, cylinders, or cups, preferably of metal or carbon, arranged to be electrically connected to a battery or other source of electric power, and arranged to be adjustable to and from the diaphragm electrode, or arranged to be supported near the same, but without touching it, the intervening space between the supporting piece or pieces, or the lower edge of the tube or tubes, and the diaphragm electrode being filled with a soft cushion, or washer or washers of leather, felt, cotton, or similar substance, openings being made in such cushion opposite to the open end of the tube or tubes. The tubes are arranged to contain, support, or carry, a certain desirable quantity of granulated carbon, or graphite, or both, thus making a variable electrical contact between the tubes and the diaphragm electrode. 5 claims.

4,610. "An improved temperature regulating device for electricity meters." E. F. Moy. Dated March 5th. Relates to an improved temperature regulating device for electricity meters, such as those described in patent specifications No. 19,134 of 1891, No. 22,852 of 1891, and others. 4 claims.

5,026. "Improvements connected with the apparatus for raising and lowering the centre lights of chandeliers and electroliers, also applicable to brackets and like fittings." R. H. Best. Dated March 10th. Consists in the separation of the extended portion of the crank arm to which the counterpois weight is attached from the crank arm to which the light is attached, and the connection of these two arms by means of rods, chains, cranks, or other methods, so that the light may balance in any position, and when applied to "pendants" that the pendant may hang plumb. 2 claims.

5,314. "Improvements in magnetic separators." S. L. Anderson. Dated March 14th. Consists in forming simple or compound projections from the sides of the pole pieces, extending upon the intermediate space and towards the adjacent pole-piece. 2 claims.

5,509. "Improvements in the manufacture of submarine cables." A. Muirhead. Dated March 16th. Consists in substituting for the closely woven tape hitherto employed a canvas fabric of open texture, or other substance or material which is reticulated in character. 1 claim.

5,721. "New or improved process and apparatus for the electrolytic decomposition of common salt." C. Smith. (Communicated from abroad by G. Jorgensen, of Bergen.) Dated March 19th. Relates to the use for containing the electrolyte a vat or vessel of an U-shape, constructed of granite, slate, or other material, lined with a suitable non-conducting substance. 2 claims.

18,217. "Improvements relating to the transmission of telephonic messages between the shore and a lighthouse, ship, or other signal station." L. I. Blake. Dated September 25th. Consists in establishing under and around the ship or station a large electrified region, between the different parts of which there exists a suitable difference of potential, and providing a metallic conductor to be carried by the ship, and the ends of which may be immersed in such region to connect two points therein between which such difference of potential exists. 2 claims.

21,250. "Improvements in or relating to multiple telegraphic apparatus." A. Pierfort. Dated November 5th. Each ordinary telegraph key or instrument is arranged so as to send over the line wire, at each manipulation of the handle, an intermittent current corresponding to a determinate number of vibrations per minute but differing for each operator. As they arrive at the receiving instruments, they distribute themselves by a self-acting selection and register themselves automatically on the several optic receivers for which they were destined. 5 claims.

21,461. "Electric motors." C. Riordon. Dated November 7th. Consists essentially—first—of constructing the core of the armature in cylindrical form with longitudinal recesses of substantially the width between the cores of the field magnets, the core of the armature being loose on the shaft and maintained from revolving by the lines of force passing through the field magnets and core, and the armature being constructed in cylindrical form around but free from the core and supported on suitable discs and—secondly—of winding the armature with a series of wire loops with the sides substantially arc-shaped bevel to fit the discs and the ends arranged to over top each other and substantially rectangular in form, the sides of the loop passing across underneath the field, being arranged to come underneath the opposite side of a corresponding loop, all the loops being arranged around the discs. 3 claims.

21,707. "Improvements connected with the electric conductors of electric railways." A. Slater. (Communicated from abroad by J. Platt, of America.) Dated November 10th. The object of the invention is to provide an improved electric railway system, in which the electric wire or conductor is entirely enclosed in an insulating envelope, the envelope being provided with means for intermittently making contact. 6 claims.

22,192. "An electric exploder." Siemens Bros. & Co., Ltd., and A. S. Schloemer. Dated November 16th. Relates to electric apparatus for effecting explosion of blasts, mines, torpedoes, and the like.

23,441. "Improvements in and connected with galvanic batteries." J. C. Fuller and G. Fuller. Dated December 3rd. Claims:—1. In galvanic batteries, the combination with a carbon plate or stick, of a piece of platinum or other comparatively non-oxidisable metal partially inserted into the carbon, a cap of lead or other suitable metal cast upon the carbon plate and around the projecting platinum, and a binding screw attached to the lead or equivalent therefor, substantially as and for the purposes set forth. 2. In galvanic batteries a carbon plate with the platinum connection, as previously claimed, a porous porcelain cell containing the carbon surrounded with the exciting compounds and the zinc cylinder covered or coated with fabric or paper impregnated with insulating material, all substantially as and for the purposes set forth.